The Journal
OF THE
Royal United Service Institution.

VOL. XXIII. 1879. No. XCIX.

WORKING HEAVY GUNS BY MANUAL, HYDRAULIC, AND STEAM MACHINERY.[1]

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THE vast increase in the weight of ordnance has necessitated a gradual introduction of mechanical appliances in working them: fifteen years ago, common tackle and levers were the only aids to manual labour; now, the gun carriage is a machine requiring the exercise of the highest skill in its design and manufacture, and of intelligence in its use; and whilst the severest bodily labour was then imposed on the gunners, ordnance of eight times the weight are now worked with less physical exertion and with greater precision of movement.

These improvements have engaged the attention of many persons, and the successful results are so numerous, that, obviously, it would be impossible for me to attempt, in one lecture, any description of them all. I propose, therefore, to mainly confine myself to a portion of what has been done in the Royal Carriage Department, and I am led to hope this course will not be unsatisfactory to you, inasmuch as, being members of either the naval or military professions, you will naturally take a lively interest in what, so to speak, emanates from the Service itself; for these improvements are the work of the engineer, guided and influenced by the immediate control of Officers experienced in gunnery, and fully conscious of the peculiar conditions attending the use of machinery in actual warfare; whilst those inventions of the engineer acting outside these influences and military experiences, tend naturally to be of a type more suited to the ordinary workshop than to the fort or vessel of war.

Working heavy guns of from six to twelve tons weight, on the broadside of ships, was the first occasion that initiated the introduction of a higher order of mechanism in gunnery, and was due to the genius of Captain Scott, R.N.

[1] A lecture delivered at the Institution on 1st of March, 1878, Major-General Sir John Adye, K.C.B., R.A., in the chair.

Curved toothed racks were laid on the decks of ships, and by means of a training pinion secured to the slide, and actuated by a train of wheels and winch handles, the gun was laid quickly and accurately by two men; endless chains, formed of flat links riveted together, were placed on suitable wheels inside the slide, which by being attached by nipping gear to the carriage, and worked by spur gearing in the slide, enabled the gun to be run in or out, and thus the two most laborious operations, hitherto calling into play clumsy tackles and large numbers of men, and being after all uncertain and jerky, were placed under the entire control of four men at most.

Owing to the necessarily confined spaces available in ships and forts in which these heavy guns had to be worked, it became, from the first, evident that no corresponding increase in the length of recoil could be permitted; in fact, from the greater length of the guns, the platforms and slides had to be shorter than those hitherto in use with light guns. It was, therefore, essential that some greatly superior form of compressor should be used, and that it should be self-acting, if possible, in order to avoid the risk of the gun, after discharge, going back to the rear with such violence as to produce a break-down, and temporarily, at least, putting it out of action. Captain Scott proposed a modification of Erickson's American compressor, consisting of a large number of sliding surfaces, held in contact by a comparatively light pressure, set up by a lever, or hand wheel, and screw. This proved to be greatly superior to anything else which was tried, and he afterwards modified it into what is now known as the bow compressor, in which the pressure is set up by the weight of the gun when it is thrown off the rollers of the carriage. A more efficient invention, however, for this purpose, was that of the hydraulic buffer now so well known, not only by its general adoption into the British Service, but also, with various modifications, by every other leading nation. Its great merits are its being absolutely self-acting, the unvarying character of its resistance when opposed to the same force, and its extreme simplicity. As considerable misapprehension regarding the nature of its action still exists in the minds of many, I may be permitted a few moments to describe it somewhat in detail.

A section of the buffer is shown in the diagram (Plate I, Fig. 1). It consists of a wrought iron cylinder corresponding in length to that of the full recoil. A piston, having four small holes, works from end to end, by means of a piston-rod, having its outer end attached to the carriage, whilst the cylinder itself is firmly fixed to the platform; in the firing position the piston is drawn to the front end, and during recoil it is forced through a fluid which partially fills the cylinder, to the rear end; during its progress all the fluid must pass through the four small holes, and it is this which gives rise to its resistance to recoil, a resistance proportionate to the velocity of recoil, and to the ratio existing between the area of the piston and that of the holes.

In the 38-ton gun carriage, the ratio of the area of the piston to that of the holes is 40 to 1; therefore the velocity with which the fluid passes through the holes is 40 times greater than that with which the piston moves at any given point; but owing to the contrac-

tion of area assumed by any fluid passing rapidly through small orifices, much less really passes than that strictly due to the area of the holes, and from this cause the actual velocity is about 60 times greater. Now the velocity of the gun immediately after recoil begins, is about 10 feet per second, hence the velocity of flow through the holes is at this point $60 \times 10 = 600$.

There is a constant relation between pressure and velocity of fluid, and by the use of a well known formula we can find out what pressure on the piston must exist to produce this velocity; it is about 47 tons, but this enormous pressure acts only at the first moment, for the gun rapidly loses its velocity, and as the resistance varies as the square of the velocity, it is manifest that the resistance rapidly diminishes until, towards the end, it practically ceases altogether.

By a simple modification of the buffer, it was proposed, on its first introduction, to do away with this falling off of the resistance towards the end of the recoil, and to make it either uniform, or greater, at the end, by diminishing the area of the holes as the gun recoiled. This was effected as shown in the diagram (Plate I, Fig. 2), by having large holes, and placing through them conical rods the full length of the cylinder, with the large ends at the rear; thus, as the gun recoiled the apertures were reduced in any required proportion. This form was tried, but the original and simpler form answered better, the recoil being much steadier, and resulting in no upward jump of the front of the platform.

The steadiness, or unsteadiness, results from the action of two forces; when the gun recoils, it sets up an enormous pressure at the buffer, which tends to turn the platform over on its rear rollers; the weight of the gun, acting with a lever due to its distance from the rear rollers, opposes this tendency. Reduction of the resistance, and consequently pressure on the buffer, in proportion as the gun acts with less leverage, is obviously therefore the proper method of keeping the platform steady, and of bringing the gun gradually to rest in place of doing so with a sudden jerk. The simple buffer accomplishes this perfectly; and the use of conical rods, spring valves, or any other contrivances for maintaining the resistance are not only unnecessary complications, but are positively detrimental. This was further illustrated by time-curves taken with each kind of buffer, from which it was proved that the time occupied in recoiling six feet was twice as long when the simple buffer was used, as was the case with the other —all other conditions being the same. While on the subject of the hydraulic buffer, I should like to draw your attention to two special features proposed in 1867 in connection with its use in the Navy, but which, owing to the delay attending its general adoption into that branch of the Service (now I am glad to say at an end), were not introduced.

The one (Plate I, Fig. 2) was the use of a solid piston having no holes, and a side pipe communicating with the front and rear ends of the cylinder, with a valve worked by a lever capable of being set so as to secure any required aperture; the recoil of the gun forced the fluid through the side pipe and the valve, the opening in the latter perform-

ing the same office as the holes in the piston; while by working the valve lever the running up of the gun was perfectly controlled.

The other feature was the introduction of a hydraulic pump and cylinder for the purpose of running the gun in or out; thus, in 1867, the Royal Carriage Department initiated the use of hydraulic appliances in gunnery, which, in 1874, expanded into a complete system, under the same direction, in connection with the 35-ton platform. During the interval between these two dates considerable experience in the application of hydraulic machines to gunnery was gained, owing to their introduction for various purposes in naval gun carriages.

Lest I should appear to claim undue credit for the department with which I have been associated for 22 years, I should mention that many of these machines are due to the suggestion of Captain Scott, and their success in a large measure was secured by the able assistance of Mr. Stephen Holman, one of the partners in the celebrated firm of Tangye Brothers and Holman.

The first of these machines was introduced two years after the hydraulic buffer. It consisted of a ram and pumps, and was used for raising and lowering guns in turret carriages to enable the guns to fire out of reduced ports.

In 1870 a different plan for the same purpose was devised at the request of Captain Coles for H.M.S. "Captain;" in that unfortunate ship, which mounted four 25-ton guns, the small port principle was met by placing the rams under the platform, and thus raising the platform carriage and gun—in place of the gun alone as in the former case—to secure the various degrees of elevation.

In the same year (1870) small turn-tables were introduced, upon which, by traversing the rear rollers of the slides on them, and raising the front ends clear of the deck, the guns might be turned from one port to another. To raise the front end of the slide and thus throw the whole weight upon the turn-table, a hydraulic lift was devised; it was secured permanently to the under side of the slide, and, by thrusting downward its ram into a bearing on the turn-table, raised the front end as desired.

Another useful hydraulic appliance, introduced about the same time as the former one, was that of the rear-roller jack. This was for performing an operation in the working of guns of great ingenuity, and, comparatively speaking, of considerable antiquity. It is one of those things which proves that the carriage builders of old knew what they were about. They did not create difficulties in order to overcome them, but chose rather to adopt the simplest means to meet what could not be avoided, and if possible turn it to some useful purpose. When a gun is fired it is forced in an opposite direction to that of the shot, and with an equal force. To hold the gun perfectly still would be to create an enormous difficulty, to allow it to recoil unrestrained on live rollers down a decline would be equally bad, although of the opposite kind. Our old carriage builders did neither, they sought to restrain its recoil within reasonable limits, and provided, by the nature of their precautions, an easy method of getting the gun back into the firing position. They checked the recoil by

making the gun ascend an incline, and created frictional resistance by making the weight of the gun act upon the sliding surfaces of the carriage and platform; thus, without the use of compressors, the gun was brought safely to rest in a position suitable for being loaded; they then used the carriage as a lever, and, by raising it on rollers at the rear end, brought into play rollers in the front, which latter sustained more immediately the weight of the gun, which then by gravitation descended into the firing position. We have now, owing to the greater force of recoil and shorter platforms, to adopt means of providing additional resistance in the form of the hydraulic buffer, but this is no reason why we should discard the simple principles of the old gun carriage. For instance, if we keep the carriage always on rollers we lose the frictional resistance afforded by the weight of the gun, and we must make our compressors so much the more powerful. If we fire on a level platform, or on one having a downward slope, we lose the resistance of gravity, or make it positively promote the recoil, while we have to provide gear for forcing the gun into the firing position, and thus create complication unnecessarily, and invite the dangers of a break-down.

All these hydraulic appliances of which I have spoken are of a simple character, portable for the most part, and easily replaced by spare ones, if disabled. The lift for turret carriages, however, having its ram and pumps separated, necessitated the employment of pipes which were liable to damage, and, besides, interfered with their easy removal, therefore, in preparing the small-port carriages of the 18-ton guns for Breakwater Fort, the ram and pumps are combined in one simple portable machine.

After the successful introduction of these various machines, it became a question whether it would not be desirable to extend the use of hydraulic power to training and running the gun in; accordingly, a design was proposed in connection with the 35-ton casemate carriage and platform, which was carried out and successfully tested in 1874. As the first example of the general application of hydraulic power to gunnery, I think it merits a somewhat detailed description.

The hydraulic buffer is modified in its form in order to adapt it to the purpose of running the gun in; a solid piston (Plate I, fig. 3) is used with hydraulic leathers to keep it tight, and on recoil the fluid is forced through an orifice into a tank provided for its reception in the rear of the platform; the orifice is of conical shape, and is enlarged or reduced to offer more or less resistance by means of a conical valve; (Plate I, Fig. 4); a pipe leading from the hand pump communicates with the front end of the compressor cylinder (Plate I, Fig. 6), and conveys water under pressure for running the gun in when required; another water cylinder is placed alongside the hydraulic buffer, and is used for traversing; pipes connect both ends of it with the hand-pump before mentioned, thus allowing of the piston-rod being forced inwards or outwards, according to whether the gun is to be traversed right or left; the motion of the piston-rod is augmented, and conveyed to the rollers of the platform by a chain and pulleys in much the same manner as hydraulic power is utilized in cranes.

Only one pump, and that a small and portable one of simple construction, is used for all these operations, the stream from it being directed by means of a slide valve (Plate I, Fig. 5) into whichever pipe will convey it to perform the required action; this slide valve is worked by a lever, and a dial plate points out the different stations to which it should be moved to "Traverse right," "Traverse "left," or "Run in;" thus, several men (in case of need one man is sufficient) working the pump, and one the lever of the slide valve, perform with ease these laborious operations.

This arrangement was tested at Shoeburyness in the presence of the Duke of Cambridge and other distinguished Officers, in competition with lighter guns worked by spur-gearing; it beat them considerably in time and accuracy, and after more than three years of comparative neglect, it was, when tried a few days since, in good working order.

The complete design embraced the substitution of steam for manual power, the hand pump being retained as an auxiliary in case of steam failing; but a curious accident which befel it in one of the preliminary trials, induced the Heavy Gun Committee to put on one side for the time the consideration of the advisability of adopting, and of wholly depending upon, hydraulic gear on so extensive a scale. The accident was the bursting of one end of the hydraulic buffer and running-in cylinder, and was due to a misuse of the levers.

I have, thus far, alluded only in very general terms to the various kinds of gear used. I must now direct your attention more in detail to the manual, steam, and hydraulic gear devised in the Royal Carriage Department for working the 38-ton gun in casemates. I have adopted this course to suit the time at my disposal, and also because the details of other plans have led up gradually to those of which I shall now speak, and which are for the most part embodied in them.

The first thing was to establish a good and efficient hand-gear, which, having been designed and prepared, was very thoroughly tested. On one occasion, 100 rounds were fired in two days, the gear being worked in a casemate erected at Shoeburyness, and representing one of the worst types as to available space. The whole of the operations were done by manual labour, including loading; two detachments of gunners were told off, one being thoroughly experienced, and the other casually selected from men under instruction; the time occupied by each per round was about the same (two minutes); each one worked twenty minutes continuously, and made excellent shooting. This famous trial was witnessed by a large assemblage of Members of Parliament and Naval and Military Officers, and was completed without a single hitch of any kind, except the break-down of a portable hydraulic jack (the only piece of hydraulic gear used), which, however, was readily replaced by a spare one.

The carriage is of the "low type," introduced into the Navy by Captain Scott; the platform is comparatively short, owing to the confined area of the work, and admits of only six feet recoil (Plate I, Fig. 7); an ordinary hydraulic buffer is used, and fully controls the recoils within this limit; the carriage rests upon the platform with its

rollers out of action in the firing position, and on the discharge of the gun ascends a slope of 4°; a portable hydraulic jack attached to the rear-end is used to place the carriage rollers in action, which admits of the gun, after being loaded, running up of itself.

The traversing is effected by means of a toothed rack secured to the floor, into which is geared a strong pinion working in the platform, so that, as the pinion is moved, it forces the platform right or left.

The running-in of the gun is accomplished by means of two endless chains placed along the inside of the platform upon suitable wheels; nipping blocks are fixed to the bottom of the carriage, and, by means of a lever, may be made to secure the carriage to the chains; motion is imparted to the chains by forcing round the toothed wheels upon which they are suspended, and thus the gun may be run in or out. Before firing, the lever working the nipping blocks is released, and the blocks fall clear of the chains by the action of a counterweight provided for the purpose.

Considerable power is required to impart motion to the training pinion, as also to the endless chains, and a combination of toothed wheels and pinions in the nature of a crab is provided for the purpose, the whole being worked by two winch handles placed opposite to each other on the rear end of the platform. This series of power-gaining wheels is intended either to traverse or run the gun in, according to whether it acts upon the training pinion or upon the endless chains.

The means for associating the power thus provided for running in or traversing consists in placing on one of the shafts two wheels running loose (Plate I, Fig. 8), that is, not keyed, as the other wheels are, to their respective shafts, but free to stand still while the shaft is revolving; between these two wheels is placed a collar or clutch, consisting of a frustrum of a cone at either end; this clutch is connected with a lever capable of moving it into a corresponding recess in the wheel right or left of it, and it is keyed to the shaft in such a way that, while free to move laterally, it is forced to revolve with the shaft in whatever direction it is turned by the winch handles. Now, suppose men working these winch handles, and setting in motion the train of wheels leading up to this clutch, if it be midway between the two wheels, motion will end in the clutch itself; but if this clutch be forced into the recess of either of the wheels, then, by the friction set up, it will carry round the one with which it is in contact; one of the two is geared with the training pinion, and the other with the chain wheels, and thus, you perceive, this double-friction clutch provides the means of carrying the power accumulated in what I have termed the crab, to either the running-in or traversing operations. While standing midway, both operations cease, even though the crab be kept going.

I have considered this clutch movement in detail, because it has a special feature of great importance when we come to consider the steam-gear. It is this, that by adjusting the taper of the cone clutch, we can make it just sufficiently powerful to set up the requisite friction to overcome the resistance to the legitimate operations, but not so great but what it will revolve in either wheel should the operation be

carried too far and meet with unusual resistance; the parts of the gear when running rapidly by steam power are thus saved from fracture.

The whole of the gear is boxed up, so to speak, under the gun, and within the sides and ends of the platform; it is thus protected from any injury short of that which would most probably destroy the efficiency of the gun or platform; it is of simple character, easily understood, and, if damaged, the damage would be readily detected.

As to its efficiency, I may refer to the speed with which 100 rounds were fired; and with regard to its durability and strength, I may state that one set alone has stood the test of over 200 rounds, many of which were experimental, with charges of 180 lbs.—130 lbs. being the service charge when it was prepared—and although the shock with the experimental charge was very severe, owing to the necessarily short recoil causing the front of the platform to be raised several inches, and letting it fall on the steel rails or racers, with immense force, yet not the slightest damage has occurred to any part of it.

I think, therefore, the Heavy Gun Committee may be congratulated on having secured a thoroughly efficient hand gear, of which large numbers have been made, and the next question was to adapt steam power to it, so as to save the labour of working it, and obtain increased speed with less exposure of the gunners.

Although there is much to be hoped for in the employment of steam power, there are some disadvantages to be considered; for while steam affords an enormous concentration of power in a limited space, and is easily manipulated by a few men, yet it involves the use of engines and boilers which are undoubtedly less reliable than the human machine. In whatever way, therefore, its employment might be considered, the contingency of having to resort to a well-tried hand gear, must form a part of the question.

Where steam power can be used under certain favourable conditions, no need exists to anticipate any necessity for resorting to man power. In a factory such favourable conditions exist, thus a pause in the work, owing to a break-down, is not of vital consequence, and is mostly of only short duration, owing to the immediate attention of skilled labour, and the ample supply of means and material; nor is a break-down likely to occur often, as the sole business of all employed is to study the action of the mechanism. The genius, so to speak, of the steam-engine and steam machinery dominates every mind, creates the prevailing thought, and animates every action.

In a fort or a vessel of war, however, all this is changed; a break-down in the gun-gear might turn a victory into a defeat, for its remedy would most likely be indefinitely prolonged, owing to the absence of ample means and sufficient skilled labour, as also to the pressure of great excitement, and the total absence of that prevailing tone of thought, so favourable to the speedy remedy being available in the ordinary workshop.

In short, there are at least two causes operating most powerfully to induce and aggravate accidents to steam machinery when employed for gunnery purposes in forts and ships—namely, excitement and an

object other than the mere care of machinery. The records of the trial trips of ships furnish a sad list of accidents, almost wholly due to the effects of excitement alone: it remains for the future to disclose how many of far graver consequence to the nation may arise from both these causes acting in combination with others of less value, if we fail to appreciate the important fact that forts and war ships are not ordinary factories.

Having then secured a good and reliable hand-gear, obviously the wise course was to retain it and to adapt the application of steam, or of steam and hydraulic power combined, to it, in such a way that it should be always in operation whichever power was employed, thus keeping its features always before the gunner, and ensuring that when steam failed, the hand-gear itself should be in good order and available for immediate use.

To have considered first the best nature of steam-gear, and then alter all the usual gunnery operations to suit it, no matter how complicated these operations became, nor how unsuitable for hand-gear, would, of course, be the easier task for the engineer. With ample steam power it does not matter whether we load, for instance, by taking the gun to the shot or the shot to the gun—whether we bring the gun into its firing position by the simple action of gravity, or by the pressure of many tons: if we add to this a disregard of the exposure of our appliances, the task is still simpler for the engineer, but the consequences to the successful operations in actual warfare are most serious; hence, the condition laid down by the Heavy Gun Committee relative to the provision of an efficient hand-gear, is conspicuously wise and soldierlike. No matter what difficulties are created for the engineer, it is his business to overcome them, and to subordinate his plans to the necessary conditions of the service, not to force the conditions to suit his inventions.

It was determined then to retain all the hand-gear which has been so well tried, and to apply steam power to it in such a way that either steam or manual power might be used, according to choice or necessity, by merely turning on the one or the other by the motion of a lever M (Plate II, Fig. 4), and I will now proceed to explain how this has been accomplished.

In the case of the hand-gear, men apply their power to winch handles, which is transmitted through power-gaining wheels and pinions, to the points where the required work is to be done. In that of steam power, the winch handles are removed as being no longer necessary, but the steam power is applied to the same wheel C (Plate II, Fig. 4) upon which the winch handles acted—so that either begins to operate at the same point, and the drill at the gun and platform is identical for both.

There is a considerable choice of means by which steam power can be transmitted to this point, such as compressed air, water, revolving drums with wire ropes running over them, and common shafting—all being good media for the transmission of power from the steam-engine, if well considered in relation to the special circumstances under which they are to be used.

Compressed air is well suited for conveying power considerable distances into mines to do work, or for rock boring in tunnelling, where its liberation, after producing its useful effect, is a positive good in assisting ventilation, not an evil as would be the case with water; but it is a wasteful and troublesome conveyer of power, and being besides of such a nature as to burst vessels containing it explosively, it is unsuitable for gunnery purposes.

Water I shall speak of hereafter, but I may mention here a common fallacy, often expressed, that water is a power in the same sense that steam is a power, and thus we hear of steam *versus* water power. Now, water cannot originate power as steam does, it can only convey it just as a common shaft does, or augment it at the expense of time, as is the case with a screw or a lever. In all applications of water to perform work, it is utterly dependent upon either steam or manual power, and can, in no case, give out a greater amount of work than it originally receives from either of these sources.

Drums working by long stretches of wire rope is a rude contrivance for conveying power to great distances, and would be well adapted for taking steam power from portable engines into trenches in siege operations.

The transmission of steam power by shafting is, however, the one most generally used. It is cheap, simple, and readily understood, and it is not liable to derangement with common care. For these reasons it has been adopted in the first instance, in connection with working the 38-ton gun by steam, although, for special reasons, it is intended also to try water for this purpose.

The power generated in the steam-engine is located in the fly-wheel, and this, being connected by toothed wheels, or by bands to a series of straight iron shafts, laid in passages underground, turns them with a force proportionate to the power generated.

In this diagram (Plate I, Fig. 9) you will see an arrangement of such shafts disposed in the rear of several guns mounted in a circular fort. All these revolve by the power of the engine, and, to enable them to work the gun, means have to be provided for connecting their motion to the gear in the platform. The simplest manner of effecting this would be to carry it on by other shafts to some point in the platform which remains stationary over some other point in the floor, namely, the pivot around which the gun is traversed. This would be easy in the case of a central pivot, but is not so where the pivot is situated in the armour plate, as is the case with broadside slides and casemate platforms; and it is this condition we have to meet. Some convenient point in the floor is selected where the fixed shafting must end, and some special means be devised of connecting this point with the platform which moves to and fro above it.

In the diagram (Plate II, Fig. 1) you will perceive this point is at A, and the platform passes, on being traversed, several feet to the right and left of it. To carry the motion of the steam-engine, which ends at A, into the platform, must therefore be accomplished by means of a shaft, one end of which is in contact with A, while the other end follows the platform; but the end which is free to move describes an

arc of a circle of which A is the centre, while any point in the platform describes one of which B is the centre. These arcs recede from each other, and can be made to coincide only on the centre line, unless some compensating movement be devised, by means of which the shaft can lengthen itself, so as to keep its moving end on the arc described by the platform.

This movement is met by making the shaft in two pieces (Plate II, Fig. 2), and sliding one within the other in the same manner as the tubes of a telescope. One has a long feather which fits into a recess in the other, so that as one is forced to revolve by its connection with A, it imparts this motion to the other, whether it is closed up, as it would be on the centre line, or lengthened out, as it is when the gun is traversed right or left.

In this way the power of the steam-engine is taken to a toothed wheel in the platform, and from it to the same wheel *C* upon which the winch handles act when working by manual power. The diagram and model illustrate sufficiently, without further description being needed, the combination of toothed wheels on the ends of the telescopic shaft which are concerned in carrying on the motion from the main shafting. A plate is used having pieces removable to allow access to the bearings, to cover over the triangular space required for the radial movement of the shaft, a groove being cut to accommodate the traverse of the piece of vertical shaft L (Plate II, Fig. 2) which takes up the motion into the platform.

The engine revolves always in one direction, and the first series of shafts does the same, but obviously the power must be provided of controlling the direction of motion, or of stopping altogether the shafting leading to each gun. This is done as shown in the diagram (Plate II, Fig. 3). The shaft in the rear of each gun has a pair of bevel wheels with a friction cone clutch, such as I have already described, between them another wheel fixed to the end of the shaft leading to the gun and ending at A (Plate II, Figs. 1 and 2) is geared with these two; the clutch keeps on revolving in one direction all the time the engine is going, but the wheels remain stationary unless the clutch is forced into one or other of them; if forced into one, it gives motion to the shaft leading to the gun; if forced into the other, it does the same, but imparts motion in a contrary direction. A lever, D (Plate II, Fig. 4), connected with this clutch, gives the man working it power to traverse the gun right or left, to run the gun in or out, and to load or withdraw the rammer according to the signal or word of command given him, precisely the same in effect as when manual power is used the men turn the winch handles in one direction or the other, thus keeping the drill perfectly intact, as the operations at the platform itself are precisely the same whether steam or manual power be used, the heavy labour alone being saved in the former case with fewer men and greater speed.

Of all the operations connected with the service of the gun, by far the most difficult is that of loading, owing to the smallness of the space between the muzzle and the shield, which also causes considerable exposure of the gunners. For a long time, therefore, it has

engaged the attention of many minds. So long ago, indeed, as 1862, Mr. Stevens, an American, brought out his steam and hydraulic rammer (Plate II, Fig. 5). It consisted simply of a cylinder and piston placed at an inclination below the deck of a vessel. The gun was depressed to bring its axis in a line with the rammer; the charge and shot were raised by a hydraulic lift to a hole opposite the muzzle, and were then driven home simultaneously by the steam rammer. An ingenious water-squirt was combined with the sponge, by means of which a quantity of water was injected into the bore.

This rammer was originally designed in connection with a fixed gun carriage, placed in a vessel, which gave direction to the gun by being steered. The ship, in fact, was the gun-carriage, an arrangement which eminently suited the rammer, but was scarcely so advantageous to working the ship. It was also claimed to be capable of use in turrets by revolving the guns to the loading hole, and in casemates by turning the guns away from the embrasure to some position suitable for the erection of the rammer.

Although successfully tried, it did not find sufficient favour with the American Government to be adopted, probably because it entailed operations which were inadmissible from a gunnery point of view, such as dealing with the gun in place of the shot, and also placing it in a dangerous position while loading.

The plan adopted for trial with the 38-ton gun (Plate II, Fig. 6) consists of a chain which is flexible in one direction, and admits of being wound round a barrel (Plate II, Fig. 2), but becomes rigid like a bar when unwound. It was devised in the Carriage Department in the year 1873, but was, I believe, independently invented by one, if not two, gentlemen not connected with that department about the same time.

The invention of the chain was one thing, however, and its successful application another, and one of extreme difficulty; indeed, at one time it was altogether despaired of, as its use involved operations which could not be permitted, such as depressing the gun to it, or raising by a distinct process the top bracket in which it worked, to bring the chain to a level with the bore. The invention of a pawl (E, Plate II, Fig. 6) in connection with this latter movement, however, solved the difficulty, and enables the two distinct operations of raising the chain to the muzzle and of driving it up the bore, to be performed by one continuous movement, initiated by putting into gear a cone clutch similar to what I have described. The Diagrams and Model show the nature and working of this chain, and it will be seen that in the absence of steam it can be worked by manual power (F).

As I have already stated, the space in which these heavy guns are mounted is very limited, and when the gun has reached the utmost limit of recoil which in all parts of the work can be allowed, there is no room at the muzzle to use the chain with full advantage, as the cartridge and shot have to be entered into the muzzle before the chain can act. To obviate this difficulty, the gun immediately after discharge is trained opposite one of the openings in the rear, and the recoil, which was arrested at 6 feet, is continued by aid of the steam gear to 9 feet (Plate II, Fig. 4), thus affording ample space for the cartridge

and projectile to run down automatically, by means of an overhead circular railway, and to be driven up the bore by the chain without requiring the presence of a single man at the muzzle.

The resistance afforded by the hydraulic buffer, and the friction between the carriage and platform, end as the gun approaches the limit of its ordinary recoil; and at 6 feet from the front the carriage is raised on its rollers, and is also disengaged from the hydraulic buffer, so that no delay occurs in applying the steam gear to run the gun back the additional 3 feet. The carriage remains upon its rollers during loading, being held by a small stop compressor, and runs up of itself to the firing position when the compressor is released. During the running-up the carriage restores its connection with the hydraulic buffer, sinks off its rollers, and releases its attachment to the running-in chains, making all quite safe before the gun can be fired.

By these means the gun is safely loaded with its muzzle pointing to the enemy. Not a single man is required to expose himself at the port, the steam gear is housed under the floor, and every part of the other gear, except the loading chain, is well protected (as it should be) by the gun itself. It is of such a nature as not to be injured by violent concussions or movements resulting from firing, nor from the chances of misuse, to which, from excitement on the part of the gunners, all gun-gear is liable.

I have now to consider the application of water in connection with steam power. The arrangement already tried so successfully with the 35-ton gun in 1874 presented a tempting combination. It could very easily have been associated with steam power by setting up steam-pumps and an accumulator, and by drawing off the water from the accumulator to do the work of the hand-pump, retaining the latter for use with manual labour when requisite; but it would have possessed this great disadvantage—that the hand-gear would have entailed the use of hydraulic gear in place of common spur gearing. Now, it is well known that hydraulic leathers and valves have a disagreeable way of suddenly failing from various causes, and the hand-gear in this case would have been as liable to get out of order as the steam gear, in fact, more so. It was, therefore, resolved to employ water precisely in the same manner as shafting, leaving the common spur gearing for manual labour, thus securing a perfectly safe, simple, and reliable auxiliary, should either steam or the hydraulic gear fail.

The power then conveyed by water from the steam engine has to be applied to the same point at which the winch handles act when manual power is used; to effect this a small water engine, G (Plate II, Fig. 7), is substituted for the winch handle. When the steam and hydraulic gear are in good working order, this engine drives all the gear in the platform. When either is out of order, this engine is thrown out of gear, winch handles are placed on the spindles, and, in a moment, manual labour is called upon to keep the gun continuously in action.

This water engine, which is the invention of Mr. Brotherhood, is a very beautiful machine. It consists of three cylinders placed at equal distances round a fourth one, the interiors of the whole communicating freely with each other; in the fourth,—the centre cylinder,—is

placed a crank fixed to a shaft and pinion, which are intended to perform the work of the winch handles—thus, by forcing round this crank the gear of the platform is set in motion to perform the various operations required. Each of the three cylinders is a hydraulic ram having a solid piston, which, by means of a connecting rod, thrusts the crank-pin round one-third of a revolution—thus each, acting in succession, completes a circle of movement and maintains an equable motion in the whole of the gear. A valve, worked by the crank shaft, maintains the proper supply of water under pressure, and also provides for the removal of the water when it has done its work.

For the conveyance of water from the accumulator, pipes are laid to some convenient point in the floor of the casemate,—and from this point it must be conveyed into the platform by means of pipes which will adjust themselves, as in the case of the telescopic shaft, to various lengths. Telescopic tubes might have been used, but tubes jointed at their ends, similarly to ordinary gas brackets, were preferred for trial. A double set of these are placed in the same recess required for the movement of the telescopic shaft,—one set to convey water under pressure, and the other to carry the waste water back to the steam pumps. The pressure water enters a valve box in the rear of the platform I, and is allowed to pass to the engine, or arrested, according to whether the gunnery operations should proceed or not. A lever regulating this valve gives the man working it the control of all the movements. He can train right or left,—run the gun in or out,—load or withdraw the rammer,—just as the man working the clutch lever does with the more direct steam gear I have already described.

I have endeavoured, so far as the time at my disposal would permit, to make you acquainted with the common spur gearing adopted for performing the various gunnery operations. I have shown you that this gearing, while specially designed for manual power, is made the vehicle for steam and hydraulic power—steam acting through common shafting, and steam acting through water. It remains only for me now to point out the relative advantages and disadvantages of these two methods of using steam power.

In the case of shafting, there is the disadvantage of not being able to vary the rate of motion imparted to the gear of the platform. It is, however, one that only applies in the case of laying the gun. In traversing large distances, great speed is required, while, for accurate laying, a slow motion is desirable. If we arrange the gear, therefore, to give high speed, we render the operation of laying the gun with great accuracy somewhat difficult, while, if we arrange the speed to suit the laying, we sacrifice the speed so desirable in traversing over large arcs. A mean has been sought between these, and a little practice in the use of the steam clutch lever has hitherto resulted in giving quick and accurate laying. Under the worst circumstances the steam gear can be disconnected in a moment, and the final laying performed by the hand-gear. By the use of water in place of shafting the speed may be modulated to any extent, and in this respect it is undoubtedly superior to shafting.

With the exception of this one advantage, however, the employment

of water cannot compare favourably with shafting. It is liable to fail suddenly, which shafting is not. When it ceases to act, the most expert engineer will often fail for some time to discover which among many parts, all hidden from view, is the one out of order. It involves the use of much delicate machinery, over and above the boiler and steam engine, while shafting only demands the use of these two. For these reasons, I cannot but think the simple shafting, in spite of its one disadvantage, will be the one ultimately preferred by practical gunners.

In conclusion, I should state that the hand-gear has been thoroughly tested, and is adopted into the Service; the steam and hydraulic gear have been partially tried, and are still under consideration. Most probably these latter will in any case only be used in certain favourable localities, as they are by no means necessities, it having been proved that guns up to 38 tons in weight can be perfectly placed under the control and power of manual gear, and fired at a fairly quick speed. I would not, however, be understood to underrate the vast importance of steam power in lessening the labour of the gunner, increasing the speed of firing, and securing better protection. All I would wish to state is, that the employment of steam is not a necessity, and being of a nature to lead to the employment of mechanism which adds immensely to the cost of mounting each gun, and to the difficulty of working it and preserving it in proper order, it is not at all probable that it will be adopted for every 38-ton gun, but rather be confined to such works as the Spithead forts. And even where employed, the simple manual gear must be retained, to ensure the guns being kept in action, should steam or the steam gear fail.

Captain R. A. E. Scott, R.N.: I merely wish to say a few words to open this discussion, as Mr. Butter has kindly referred to my plans, which he well knows from our having been so closely connected in carrying them out while I was at the Admiralty. I will, therefore, say what I have not had the opportunity of saying before, that it was mainly due to the loyalty with which the Arsenal developed and carried out my own and other plans, that so large a measure of success in mounting and working heavy guns at sea has been reached. To fully realize the value of this result, we must consider how important is that success to the maintenance of our maritime power; for, however admirable the gun itself may be, and the gun has been admirably manufactured in the Arsenal, unless there are the means of pointing it accurately, the gun can be of very little value in actual warfare. It amounts to this—that if we have not accurate appliances for pointing our heavy guns and for handling them with *certainty*, so that they will not fail us in action—then it is clear, that the vast weight of armour that we put upon the sides of our vessels to protect their ordnance, the top-heaviness thereby caused, and the immense sizes of the vessels constructed to carry this ordnance (which, even in such ships, necessitates a reduction in engine and coal-carrying power, to bear such a mass of thick iron coating), are a *very great mistake*. Granting, however, that the gun dominates all other naval weapons, then it must be a most important point that we should have the very best appliances for working them, and I think, from what Mr. Butter has now shown, that you have such means at hand. I entirely concur in what he has said, and were I to attempt to lecture to-morrow on the same subject, I should commence by saying, let us have the well-tried hand-gear with which our sailors are already familiar. Put upon that any steam or hydraulic power you choose, but let the present hand-gear be the foundation of the system. Mr. Butter has said rightly, that up to guns of 35 tons weight, this hand-gear has worked perfectly, and I do not think that any purely hydraulic power, which has been used afloat, has as yet

caused the guns to be worked so quickly as the "Devastation's" guns are now being worked by the usual service appliances, which are actuated by manual labour. The "Devastation's" guns are, however, 35-ton guns, and some of those that are worked by hydraulics are 38-ton guns. I feel very strongly indeed on this subject, having urged that the simple hydraulic gear, which had been already adopted for lifting turret guns from step to step in their carriages, should be extended to working all the gear in the case of the 35-ton guns, being actuated by a steam pump; but I was met by the objection that a line was drawn between the 35-ton and the 38-ton guns, steam and hydraulic gear being necessary with the 38-ton but not with the 35-ton gun, and there the question has rested. I hope, however, the time is now coming when all jealousy will be put aside, and when Englishmen will go shoulder to shoulder, for unless they do, it is clear there will be great difficulty in maintaining our place in the world. I think, when we see the combinations that are going on around us, that every Englishman with a mechanical mind, and, more especially, every Officer capable of lending assistance, should do so to the utmost of his power, not so much in exposing what is wrong, as in showing how the very best system can be developed and maintained in Her Majesty's service. With respect to naval armaments, my own view is that *all* our turret guns should have simple steam machinery added to their present simple appliances, so that the running in and out and all other laborious operations should be done by steam, and then there would be the hand power always ready to be fallen back upon in case of the steam failing. Were this system carried out, the men would, on having to work the larger guns, such as the 80-ton of the "Inflexible," be enabled to at once handle the gear efficiently, from having become familiarized with similar appliances in working the lighter guns. What we require with respect to the guns themselves, is, I think, to make the *present* weapons more efficient, rather than to gain the required power by adding to the weight of our ordnance. I am aware that stronger or additional gun-carriage appliances are required when you get a higher recoil, but these are easily added; the urgent need for improvement is apparent, when you reflect that our 18-ton gun gives a velocity of only 1,300 feet a second, while two of the German naval guns, one a 50½-ton and the other a 14-ton, give velocities of 1,600 feet a second; the former velocity representing a force of only 17, but the latter a force of 25½. I think, therefore, it is time for us to be putting our shoulder to the wheel, so as to secure that this great mechanical country shall not be behind any nation in the world, either in weapons of offence or defence. Let us, therefore, secure for our Navy the very best tools that can be got. The discussions here are important, from calling attention to our military requirements in this age of progress, and showing the necessity for expenditure. We all must credit our authorities with the earnest desire to have the very best weapons that can be obtained, but these are generally the most costly, and, therefore, one feels the more satisfied to know that the public as well as the Services give some weight to what is elicited here. Although I have already alluded to the assistance rendered to the Navy by the Arsenal departments, I cannot avoid mentioning that the Superintendent of the Carriage Department on one occasion said to me—"Everything must give way to the wants of the Navy, it "is the Navy that we are bound to assist, and the Navy shall be assisted to the "utmost of our power." That was the spirit that then ruled, and which has, I believe, obtained ever since. Mr. Butter has omitted to say how great the efficiency of the naval armaments is due to the co-operation and assistance of the Royal Arsenal; and, but for the Arsenal aid, any man without a factory at his back must have made a complete failure. I, therefore, now wish to say that I am especially indebted to the Superintendents who so kindly assisted me, for the amount of success which my plans have obtained. With respect to these plans, I do not say that our gun-carriages are perfect, for, I believe, if we had continued to work together a little longer, a greater amount of perfection would have been reached. We are, however, in this position, viz., that of being on the right road for working the whole of our guns in a manner not inferior to that of any country in the world; in fact, every other nation has copied from us. If we had made an equal advance in the system of rifling guns, improving projectiles, and in other gunnery matters, I should then say we were far ahead of all the nations in the world. I think you will all see that nothing can be more perfect than the steam appliances shown, and

will agree with me that similar fitments should be added to all our turret guns, so as to familiarize their crews with steam and hydraulic machinery. The importance of this training may be seen from the fact that some of our largest vessels mount only four guns, and fancy what the effect would be if one or two of those guns failed, as is not unlikely to happen in a prolonged action. In addition to steam for turret guns, we should apply to all guns an invention which the Arsenal has perfected, and which, I am quite sure, you have heard described with as much pleasure as I have myself; I allude to the plan of loading by the *chain*. By this means, ships that are low in the water could lower their broadside ports, and the men will be able to load protected both from musketry and the wash of the sea. In our turret vessels, where the space is confined, whatever the position the turret is in, while pointing and firing one gun, the crew could be loading the other. I, therefore, look upon the chain loading as a very important invention, and, from the increased facility it affords for working naval ordnance, I trust it will be adopted, so as to give to our soldiers and sailors alike the very best appliances for working the heavy weapons that have been made for them.

Mr. J. Scott Russell, F.R.S.: I should be very sorry if this very valuable paper was not fully discussed by the various professions connected with it. I am very glad we have heard from the sailor what his view on this matter is, and perhaps you would allow me, as an engineer, to speak against my own profession, and to speak against every complicated engineering mechanism in the gunnery of ships, and to say, that for that very reason I highly appreciate this paper. I do so because it puts forward, as the basis of everything, that the guns shall be so arranged as to be efficiently and expeditiously worked by hand. Now I, as an engineer, appreciate that fact more highly than I do any clever little tricks and inventions of my own as an engineer; and I would say that there is this great point, that you will get more out of human beings capable of mechanical power in a short time than you will by mechanical engineering. That is the great advantage of hand power. Then, having first got perfect hand-gear, for which, I believe, we are chiefly indebted to Captain Scott—having first got good hand-gear for our Navy guns, it then becomes the second question, which the writer of this paper has so admirably coped with, how we shall apply mechanical power after that, without interfering with the efficiency of the hand-gear, and the great merit, I think, of his paper and of the inventions he has brought forward is, that he has shown how the hand-gear can be combined, in an extremely simple manner, with steam and hydraulic-gear. I will go to issue with him on one point; I do not think that hydraulic-gear or shafting is a good naval mode of conveying power from the steam-engine of the ship to the guns. I entirely disapprove of them all, from the inconvenience to which they are liable and the derangements to which they are liable, and I differ with him *in toto* upon one point. I think that the simplest mode, the most efficient, least inconvenient, and least derangeable method of conveying mechanical power from the engine, in the engine-room, to assist our sailors in the manipulation of the guns, is condensed air; and I will tell you why. All these mechanisms are liable to derangement, all of them are liable to escapes, and all of them have grave inconveniences when they go wrong, except the air. What happens if an air-pipe goes wrong? Of course you would have a spare air-pipe for every gun. If an air-pipe goes wrong this happens, merely that good, fresh, excellent cool air comes into the compartment where the pipe has burst; therefore, you have there the least possible complication of power and no possible inconvenience arises from derangement; whereas, if one of your hydraulic pipes burst, where are you? "you are inundated." That is a matter on which, I think, you will agree; we may all have a difference of opinion, but, allow me to say, I do not see any inconvenience in the attachment of an air-pump to the engines of the ship, which air-pump pumps into a large reservoir or thing like a boiler, which is in the engine-room along with the other boilers and under the management of the Chief Engineer; and, if from the reservoir a small pipe, like a gas-pipe, goes separately, under water if you like, wherever you think it is best protected, behind the armour, into each gun casemate, there is a perfect engine with the least possible mechanism and hardly any inconvenience, and much simpler than any other. Allow me to say, with regard to the hydraulic buffers, they have been used in every possible way by many of our great gunners and engineers.

I think hydraulic buffers are good, and I will only venture one remark, to say I have used these hydraulic buffers for various important purposes; but that I find the best form is not that form in which there are openings in the pistons, nor the other form in which these openings are varied by taper tubes; but what I have found the best form is this, to take the hydraulic cylinder with its piston, and then, on the outside of that, carry a tube from one end to the other, and upon that tube put a simple stop-cock, and this simple stop-cock, turning round at different angles, makes an absolutely perfect regulator, which the gunner can adjust to any purpose he wants at all times, and it utterly avoids any complication in the inside.

Mr. Faucus: Mr. Scott Russell has already anticipated much of what I would otherwise have said, and I would simply follow his remarks by suggesting how your traversing may be independent of the gun or gun-carriage. Mr. Butter made many observations with which I entirely agree. The difficulty of traversing I perfectly agree with, and I have, within the last few days, submitted this little apparatus to show a new traversing movement. That is a new application of the old elliptical trammel apparatus for drawing ellipses. Instead of the screws, I substitute bearings travelling on wheels. This arrangement is applicable to the smallest boats or to the largest frigates, for by it you obtain an elliptical movement, enabling your men to follow any rapid sailing craft at which you may be aiming. The same principle will apply to the Gatling guns in the tops or in any other position; and I have now great pleasure in submitting this model for your approval. (A model of a gun-carriage, slide, and platform was exhibited.)

Admiral Selwyn: When Mr. Scott Russell spoke of the point on which he was at issue with the author of the paper, I thought he was going to refer to an invention very little known in England, but considerably practised in America, which is very ingenious, and may possibly, in some cases, aid very much the labours of those who have the working of heavy guns. The Americans have found that the use of steel wire rope supersedes shafting altogether, that you may turn a steel wire rope round any corner you please in any direction, and it communicates the rotary movement perfectly in that new direction. You then do away with all the difficulties and dangers of the breakage of cog-wheels, and it seems to offer every advantage we can ask for, except that you must be careful never to use it in the reversed direction, otherwise you untwist the rope. But that is easily overcome by the frictional arrangement which has been proposed here. I think, if I recollect right, when Colonel Moncrieff was in Waterloo Place, I spoke to him about our chain pump when we were on the question of a flexible rammer, and told him how to stiffen the chain, and how to put it into the bore of the gun. I presume it went to Woolwich, and I am very pleased to see it has been so beautifully perfected, and so successfully adopted.

Mr. Butter: I am very much obliged to the gentlemen for their kind remarks. With reference to myself personally I have nothing to say with respect to what Captain Scott has said. He has not joined issue with me on any point in the lecture, therefore there is nothing for me to speak about further than this, that I am very glad that he has such a kindly remembrance of the intercourse which took place between us years ago, and also of what took place between himself and my then superintendent, Colonel Field, whom I am very glad to see present to-day. I may take this opportunity of saying I have not mentioned any of the Officers connected with the Arsenal or the Heavy Gun Committee who have had dealings with these inventions, because I thought it better not to do so; but I have mentioned some gentlemen who are not connected with the Arsenal, such as Captain Scott and Mr. Holman, to whom, as being outside the official circle, it was due that I should mention their names.

With respect to the remarks made by Mr. Scott Russell as to the use of air, I stated in the paper why I thought air was not a suitable agent for carrying on the steam power. I mentioned, as he did, that there was this advantage, that when the air escaped it promoted ventilation, and that it was also a most convenient way of carrying power to great distances; but still it has this disadvantage, that it is rather a difficult agent to deal with, and that it is almost impossible to keep the tubes perfectly tight. Air is very insidious, and escapes from joints in a manner that we can hardly control, except by means which are apt to get deranged by the rapid and

violent concussions caused by the discharge of the gun. There is also a great loss of power. Over 60 per cent. of the steam-engine power is lost in its transmission, and that is a very serious matter. The loss varies with different pressures. According to experiments that have been carried out the loss is, as I have stated, 60 per cent. with two atmospheres of pressure: with the higher rates of pressure the loss becomes greater than that, and with smaller pressure the loss becomes less, therefore the higher you condense air, the more is lost through its subsequent expansion.

Mr. SCOTT RUSSELL: That loss is not of the least value.

Mr. BUTTER: No. Of course it may be compensated by having higher engine power.

Mr. SCOTT RUSSELL: It is only a loss of two pennyworth of coal.

Mr. BUTTER: Then there is the disadvantage of the air reservoir bursting explosively, and that is not the case with water or shafting. If the shaft becomes deranged it produces no evil effects: it does not give out anything offensive. Of course, if a steam pipe were to burst it would be offensive, but a shaft becoming deranged would not be so in the least degree, and by disconnecting the gear from the steam-gear you can at once resort to your manual power just as if an air pipe burst. There will be no more inconvenience in the one than in the other.

With respect to the bursting explosively that is a serious matter. I believe there is a gentleman present who used air in his works for some time in place of steam, and I think he had several accidents. There were several explosive burstings, and they resulted in great injury to the men. The air, therefore, was abandoned, and water substituted for it. We know also that we have had one of the torpedo vessels burst at Woolwich, and we know that air does burst explosively in the same way as gunpowder and steam, and produces very destructive results. Another great disadvantage in the employment of air is that you must increase your complication. You must have another engine at the gun to develop the power which the air or water receives from the steam-engine. With shafting that is not the case. You carry on the power and take it off by a simple toothed-wheel. You must have a very delicate and complicated machine indeed at the gun for the purpose of re-developing the power of the air. With regard to the hydraulic buffer I may mention that the hydraulic buffer that he first mentioned is one that we have had in use for a great number of years at Woolwich, and it is a very admirable form of buffer; it was one which was proposed specially for use in the Navy, and of which I have shown you a diagram. It was proposed in 1867. It has the side pipe and the valve, and gives, besides the power of controlling the running in and out of the gun, that of regulating the aperture to accommodate itself to any recoil. But the one with the four small holes is so remarkably simple in its form, and has answered so admirably, that it is retained in preference to any other.

With respect to the traversing arrangement of Mr. Faucus it is a very ingenious application, but I do not think it bears upon my lecture, and therefore it does not fall within my province to criticise it in any way.

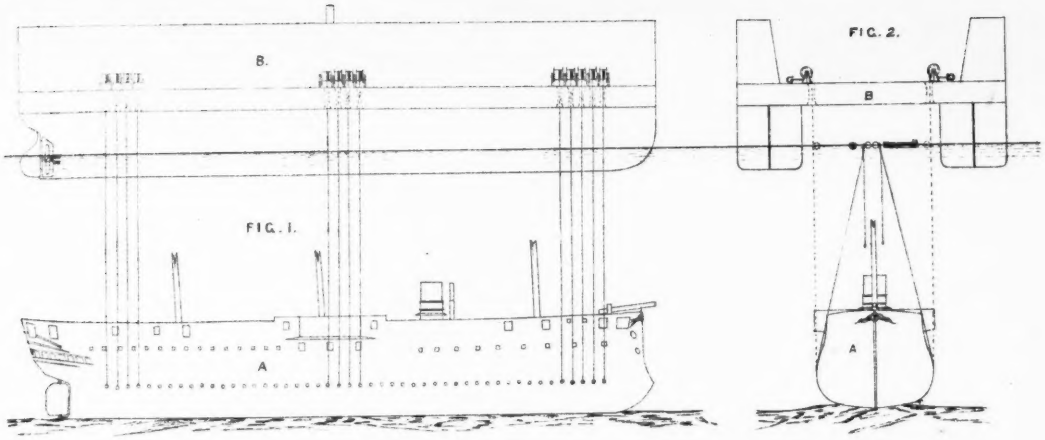
With regard to the wire rope mentioned by Admiral Selwyn, I think I named that it was one means which might be adopted for the purpose of conveying power from the steam-engine to the gun. I also named that it is a very admirable contrivance for carrying power from a portable steam-engine into trenches where there is plenty of space for large pulleys, but it is not so well adapted for carrying the power into a fort, when there are only small spaces to work in, and only a certain limited depth in which to construct the passages under the floor; it is the same way with regard to ships. The shaft, on the other hand, gives the power of carrying along the power in a very small passage indeed—only three or four inches deep. You could not carry a long rope in so small a passage as that.

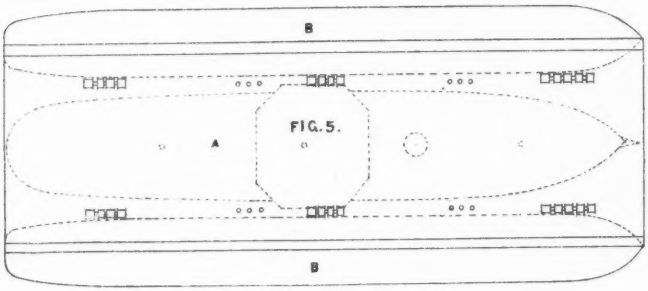
Admiral SELWYN: The steel rope is merely used by twisting for the purpose of imparting motion.

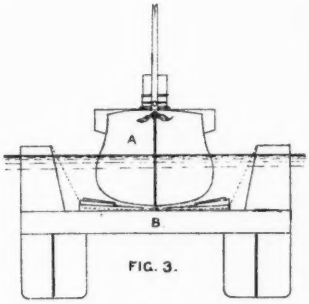
Mr. BUTTER: I misunderstood you. I am very glad of your correction. Then it comes to this, that it is really flexible shafting. This is in use in the Arsenal, and it is a very useful contrivance for carrying on a small amount of power, but it is restricted in length. It is introduced for the purpose of drilling holes up to one inch in diameter, but you cannot use such a shaft more than about eight feet long. Of course, if you only want a small amount of power it answers the purpose, but it

becomes useless when you have to get such enormous pressure as you require for the purpose of working heavy guns. They are in use both in the Gun Factory and in the Carriage Department, and the result was such that it naturally suggested itself to us as being advisable to employ a shaft of that description; but on going over the matter carefully we found it would not carry enough power for the lengths which would be required, and the telescopic shaft does convey the power very admirably, and does not give rise to any inconvenience whatever. I have only to thank you for the attention you have given me, and to add that I should have been glad to have made the paper more interesting; but we have lately been so very busy that it has been only under great difficulties that I have been able to complete the paper at all.

The CHAIRMAN: I feel sure I shall only be fulfilling your wishes in offering to Mr. Butter our acknowledgements for his kindness in giving us this interesting lecture on a difficult subject, one of great interest to naval and artillery men—and especially for his coming under the circumstances he has just mentioned—that the Carriage Department at the present moment is so fully engaged that it was with difficulty he has been able to prepare his lecture. We should probably have been much surprised if we had been told ten or even five years ago that we should be sitting here to discuss the best application of steam machinery to the working of our heavy ordnance. The fact is, it is one of the results of that great revolution which has been going on with regard to ordnance during the last twenty years, and which does not at present show signs of abatement, our ordnance, their carriages, appliances, and projectiles, are becoming so large, and the weights so enormous, that we are as it were almost forced into some system of supplementing manual labour. No doubt, as Mr. Butter has pointed out, it is essential that we should retain the means of fighting our guns by manual labour, but there are great apparent advantages in the use either of steam or hydraulic machinery. One advantage is that less men are required for manning the gun; another, that fewer men are exposed in the casemates during an action. That is important, because you know perfectly well what confusion and loss would arise from a projectile bursting in a contracted casemate. There is, however, another advantage, perhaps more important than all, that we hope, by means of steam machinery, to obtain greater rapidity of fire. Now, rapidity of fire with a field-gun is not a matter, perhaps, of much moment, but it is otherwise with heavy guns, because the object fired at will generally be a moving one; and it is evident that if an ironclad or other ship is rapidly moving across your front, it is of the highest importance to be able to strike quickly. Therefore, one of the great elements of advantage we hope to gain from this application of steam or hydraulic machinery, is that we shall get rapidity of fire. I wish to say one word about muzzle-loading rifled ordnance. That system has the great advantage of enabling us, even without the application of steam machinery, to fire faster than with guns constructed on a breech-loading system. There are so many operations to be performed in loading the latter, and they require so much care, that the firing is much slower. Mr. Butter has told you that our 38-ton gun has fired ten rounds in twenty minutes, or about one round in two minutes without steam machinery. I am not aware that any gun of a foreign Power of that calibre and weight, made on the breech-loading system, has been fired with anything like the same rapidity. But I must go further and point out that the application of steam machinery seems more simple when applied to a muzzle-loading gun than to a breech-loader. Therefore, I think we are not only right in studying the question of steam machinery, but that the system we have adopted for our guns is well adapted for its application. I was glad to hear the remarks of Captain Scott with regard to the Officers in the Arsenal, and feel quite sure that they have no petty jealousies, but that they are anxious to obtain the assistance not only of brother Officers, but of others from whose efforts we have already received so much advantage. I would name Captain Scott himself, and Major Moncrieff, and also Sir William Armstrong, and Mr. Rendel, by whom two guns have been fitted up in one of the forts at Spithead for the very purpose of developing a system of working by steam machinery. In the prosecution of our studies in this difficult matter we cordially invite the assistance of those who may not be in the department. I have only to conclude by thanking Mr. Butter for his kindness in coming here to-day, and giving us this excellent lecture on such an important subject.


B.
A
FIG. 1.
B
FIG. 2.
A


B
A
FIG. 5.
B


A
B
FIG. 3.

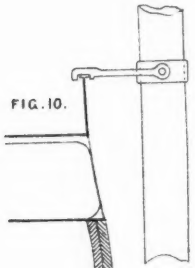


FIG. 10.

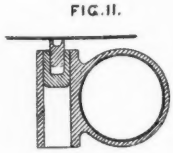
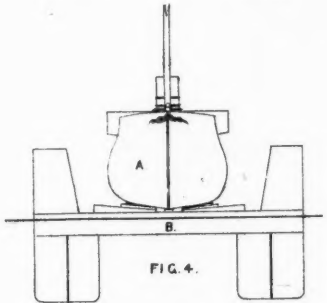


FIG. 11.


A
B.
FIG. 4.

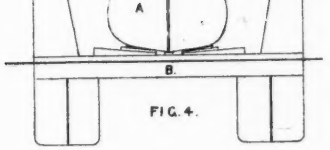
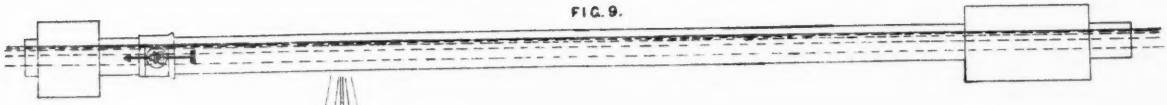


FIG. 4.

FIG. 9.



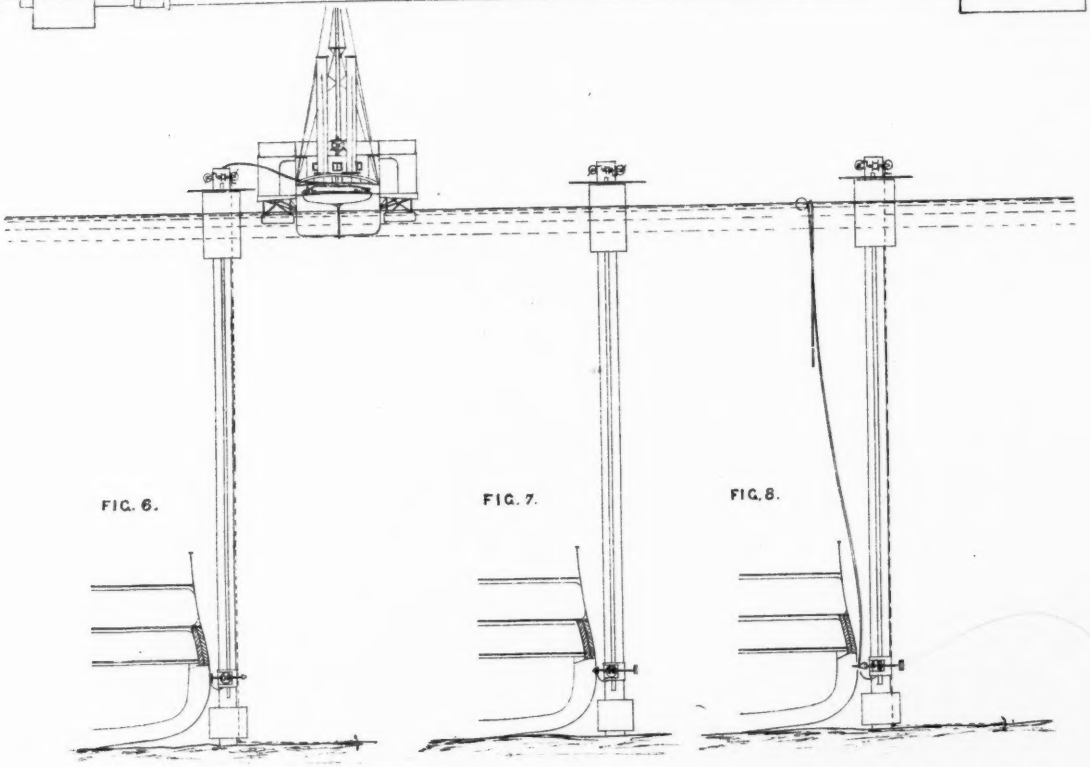


FIG. 6.

FIG. 7.

FIG. 8.

Harrison & Sons Lith. St Martins Lane, W.C.

Evening Meeting.

Monday, January 20, 1879.

REAR-ADMIRAL AUGUSTUS PHILLIMORE, &c., &c., in the Chair.

ON AN ECONOMICAL MEANS OF RAISING IRONCLADS SUNK IN DEEP WATER.

By DRUITT HALPIN, Esq., Memb. Inst. M.E., Assoc. I.C.E.

SINKING large and costly ironclads, both intentionally and accidentally, has now been reduced to such an exact science, that it appears the time has fully arrived when the art of recovering them should be placed on a similarly well-defined basis. All proposals hitherto made in this direction have naturally been received with disfavour, emanating as they generally did from persons totally incompetent to deal with the subject. The chief difficulties that have lain in the way of enterprises of this kind have been, in the first place, the absence of a suitable means of getting hold of the submerged vessels; and, in the second place, the enormous cost of the plant necessary to float them, and which at best, if successfully used, could only be used again for similar purposes. The importance of the subject at the present time can hardly be overrated; and it is extraordinary to observe how much it has been neglected, seeing to what a great extent it will probably have to be used in the event of any naval hostilities. In field artillery, where much smaller weights and less valuable objects are dealt with, a necessary part of the drill and equipment consists in recovering guns which have accidentally become disabled, and it is hard to see why a similar course should not be pursued with the more costly ironclads, where such a great value is necessarily placed in one single bottom. If the importance of the subject is not thoroughly realized and practically carried out in times of peace, it is evident that it will present very much greater difficulties in the necessary hurry and bustle of actual warfare.

The plan proposed by the author consists essentially of two distinct features: one of the employment of a suitable iron tower for making attachments to the sunken ironclad, and the other the construction of a vessel capable of lifting such ponderous weights, which can subsequently be used permanently as a floating dock for dry docking

vessels, and which is capable of transporting itself without the escort of any tugs or men-of-war to the most distant stations. The following figures show the general outline of the system proposed. Fig. 1 shows a side elevation of a submerged ironclad A, with a sectional elevation of the floating dock B, when it comes into position over the wreck. Fig. 2 gives an end elevation of the wreck and dock. Fig. 3 shows the dock submerged, ready to receive the floating ironclad A. Fig. 4 shows the dock afloat, with the ironclad docked in the ordinary way, and completely out of the water. Fig. 5 shows a plan of the dock, the dotted outline of the ironclad showing in the centre. Fig. 6 shows the tower in position alongside the submerged wreck, when in the act of clearing away the seaweed, preparatory to making the necessary hole for making the attachment. Fig. 7 shows the boring of the hole. Fig. 8 the placing of the attachment. Fig. 9 gives a view of the boring-tower when being towed out to the site of the wreck. This tower is constructed of boiler-plate, and is of a length suitable to the depth at which work is being carried on. It is permanently closed at one end, and immediately over this end there is a quantity of cast iron kentledge used as ballast; the object of ballast in this particular place being to lower the centre of gravity of the whole structure. At the other end it is capable of being readily closed at will by a manhole door. At the bottom of the tower, outside the chamber, there is an annular jacket into which water can be let at pleasure by suitable valves; and at the top there is a similar jacket which can also be filled and emptied at pleasure. In both these jackets there are several radial bulkheads. Shortly above the cast iron ballast at the bottom of the tower there is what may be called the working chamber, as from this chamber all the operations for making the necessary attachments to the wreck are conducted. This chamber has several strong glass windows round it at various heights, and the work is carried on by the aid of an electric lamp. When the lamp is kept inside the tower, a black canvas tube, similar to that used by photographers, is conveyed from the end of the lamp to one of the windows, the object being to prevent the light from blinding the men working inside the tower. The lamp may also, when desired, be lowered directly alongside the wreck outside the tower. In all cases where light is exhibited, fine jets of paraffin are ejected to get rid of the undesired presence of fish, which would otherwise totally obstruct the view. Outside the working chamber there is a strong axis, which carries a long steel bar; this bar having all the motions of a vice handle, that is to say, it is capable of rotating round its own axis, and of revolving in a vertical plane, as well as of being run in and out through the central axis carrying it. The whole of these motions are produced by a small three-cylinder engine, worked by compressed air, this air being supplied from a compressor working on board a tug in attendance. The tube is built horizontally on baulks close to the water, and, when ready for launching, the manhole door at the top is closed, as well as the valves on the outside of the top and bottom annular jackets. The tube is then launched into the water, where it floats like a spar, and is towed to the wreck. When it has arrived *in situ* it is sunk by opening the

air-valve in the bottom jacket, and thus partially destroying the buoyancy. The manhole door is now opened, and a man goes down in an arm-chair to control the motion of the machinery for making the attachments. As all these attachments are made by the aid of the engine, it will be obvious that the man has no exertion to undergo, but has merely to watch and guide the operations. The manhole door at the top being always open, it is clear that the man always remains under atmospheric pressure, and is not subject to the unfavourable conditions under which divers have to work. In order to bring the tower exactly into the required position, four anchors are laid out before the tower is sunk. Light steel wire ropes are made fast to these anchors, and passed round blocks at the bottom of the tower. It will be evident that, by heaving in and paying out these ropes, the tower can be moved in any desired direction. It is assumed that the whole of the wave-motion which takes place on the surface of the water does not extend for a greater depth than say 15 feet; and if this assumption be correct, it is hard to see how the tower can ever be brought much out of the perpendicular by the force of waves existing at the time on the surface; for it must be remembered the tower is round, and only about 4 feet in diameter, thus offering a very small resistance to the waves. Of course, it is not assumed that this machinery can be worked during gales of wind; but, on the other hand, the author does not consider it necessary that absolutely smooth water is a *sine quâ non* to the undertaking. However, to counteract any small effect which might be produced by the vertical oscillation of the tower, it is proposed to control the oscillation by heavy chain cables attached to large anchors, these cables being made fast to the top of the tower.

When the tower has been placed in exact position, the attendant causes the bar to assume a horizontal position, presenting the end of it to the wreck, which carries a large steel wire brush. The bar is then caused to revolve rapidly by means of the engine. By this means the seaweed is cut away, and a clean place for further operations is obtained. The exhaust air which has worked the engine is ejected immediately under the place being cleared of seaweed, the object of this being to cause an upward current to carry the seaweed away; its removal otherwise would be very slow and difficult, as its specific gravity is almost the same as that of sea-water. When a clear place is thus obtained, the bar is made to revolve in a horizontal plane until its other end, carrying a drunken milling tool, touches the side of the vessel. This tool is like an elongated shot, being hemispherical at one end, this end being cut into fine grooves or mills. The object of making this tool drunken, or not fixed firmly on the shaft which drives it, is to prevent its being broken by any slight movement which might take place in the tower. This tool is then made to revolve by means of the engine, and mills or grinds its way through the ship's side. The hole thus made is preferably placed a short distance below the shelfing plate which carries the armour. After the hole has been made, the tool is withdrawn, and the boring bar is placed in a vertical position, parallel with the axis of the tower.

A suitably formed rail is fixed along the outside of the tower, in line with the boring bar when the latter is placed vertically. A small carriage runs up and down this rail; this carriage carries a casting called a carrier, and into the top of this casting the toggle attached to the end of the steel wire rope which is to form the attachment is placed. This toggle for strength is made of compressed cast steel, on account of the great strength and uniformity of that metal. It is so formed that, when supported only by the rope, it always hangs horizontally. It is small at the ends and thick in the middle, enabling it to be introduced into the hold on account of the smallness of its end. When once the middle part has passed the hole it falls in easily, and it is impossible to withdraw it. The hole in the toggle for the attachment of the steel wire rope is so formed that the toggle prevents the rope being cut by the jagged edges of the plate. The toggle is inserted in the hole by the boring bar releasing the carrier which carries the toggle from off the carriage. The boring bar is then moved into a horizontal position, when it is run out, and the toggle inserted into the previously formed hole. When the operations of brushing, making the hole, and shipping the toggle, have been performed, the tower is moved a suitable distance, say about 5 feet, fore and aft the wreck. It will be observed that the whole of these operations of brushing, making the hole, and shipping the toggle, are performed at one operation, without removing the tower, so that no time is lost in looking for holes already made. Should any accident occur to the machinery making these attachments under water, the man goes up to the top of the tower, closes the manhole door, and goes on board the tug. Compressed air is then admitted to the lower jacket, which expels the water, and the buoyancy causes the tower to rise horizontally, and float on the top of the water. The radial bulkheads, before referred to, in the annular jackets, are for the purpose of producing buoyancy in any part of the jacket. It will be clear that, by these means, it is possible to rotate the whole tower completely in the water, and expose any part of the machinery to view that may need attention. The first operation undertaken at the wreck is to clear away all the standing rigging and masts. This is done by lowering the tower alongside the rigging, and by attaching suitable cartridges of gun-cotton to the rigging by means of special clips fixed in place on the rigging by the aid of the boring bar. After the whole of these cartridges are properly placed, the tower is removed, and the cartridges are fired by electricity. The masts are cut off by the board, by having circular cartridges lowered down on them from the deck. These cartridges are similarly fired by electricity, and the whole of the masts and rigging are towed bodily away by tugs. When the rigging and all other obstructions have been removed as described, attachments are made in the manner already referred to. After the rigging has been cleared away, two wrought iron booms, about 3 feet in diameter and $\frac{1}{4}$-inch thick, and of suitable length, are lashed together, and moored fore and aft over the wreck. As a precaution, these booms are stuffed with cork, to prevent them sinking, in case of holes being accidentally knocked in them. Gripping clips are fastened all along outside these booms, and

as each attachment is made to the wreck, the other end of the steel wire rope is rove through these gripping clips and cast overboard. These booms are hauled down say 2 or 3 feet below low water, so that there may always be an upward pull on all the wire ropes attached to the wreck.

When the whole of these preparations are made, the lifting is commenced by means of the floating dock now to be described. This consists of two complete vessels suitably divided by bulkheads, and having screw propellers and rudders at the stern, and fitted with powerful centrifugal pumps. The engines which drive the screws are capable of being disconnected to drive the pumps when wanted. The two vessels are braced together, at a suitable distance apart, by very strong wrought iron girders, and these wrought iron girders are completely boxed in top and bottom by a continuous iron deck, thus forming a large hollow platform on top of the two vessels. Longitudinal air chambers are constructed at the sides and top of this platform, the object of these chambers being to control the dock when the latter is being submerged in order to dock a vessel. The vessel when docked is supported altogether by bilge blocks, drawn in from the opposite sides, no shoring being used or considered necessary. Two continuous shafts run along the upper deck, driven from the screw engines. These shafts drive powerful capstans for winding up the steel wire ropes attached to the wreck, these steel wire ropes passing through cast iron hawse pipes connecting the lower and upper decks. The dock is brought over the wreck, as shown in Fig. 2. This, of course, takes place at high water, and the dock is then perfectly light. Boats are sent in underneath the lower deck and between the two vessels forming the sides of the dock. The hands in these boats cut the lashings adrift which held the floating booms together, carrying the steel wire attachments. The moorings of the booms are also cast off. One boom is then taken to the starboard, and the other to the port side, and the ends of the steel wire ropes are passed up through the hawse pipes and attached, one by one, to the winches on the upper deck. These winches are put in motion by being connected by gearing to the longitudinal shafts driven by the main engines. Each winch is independent, and being driven by friction gearing cannot be overwound. As the tide falls, all the ropes are simultaneously tightened up, and the dock sunk by water being admitted into the bottom until the lower deck is nearly level with the water. At low water pumping is commenced, and a vertical rise is made due to the height of the tide plus the excess of buoyancy of the dock over the wreck. As soon as the wreck is lifted the dock steams in shore until the wreck grounds, when water is again let into the bottom of the dock to sink it, the wire ropes being wound in at the same time. The sinking continues as before, until the lower deck is close to the water. Pumping is then commenced, and another similar fleet in shore is made; the operation being continued until the lower deck of the dock is close down to the spar deck of the wreck. The last fleet in shore is, of course, made at high water. The wire ropes are then cast off and the dock floated away

from over the wreck. During the receding tide a good part of the wreck is of course out of the water, when the holes made for the attachments can be stopped up, as well as any caused by a collision which may probably have sunk the vessel. The wreck is then pumped out and thus floated, and the dock is sunk as shown in Fig. 3, and the wreck brought into the position also shown in that figure. The dock is then again pumped out until it rises into the position shown in Fig. 4, when the wreck is perfectly high and dry in the floating dock. It will, of course, be evident that all the compartments in the dock can be filled up with coal, to enable the dock to steam to any desired station: and as the coal is burnt, the compartments can readily be filled with water, this keeping the dock when under way always at a uniform trim. Should it be objected that many stations exist where it would be advantageous to employ such a dock, but that at present it is impossible to do so owing to the want of suitable harbours, it may be remarked that an efficient breakwater could very readily be constructed, which could be carried to any desired station by the dock itself. This breakwater would consist of a number of triangular-shaped floating iron caissons, these caissons being moored by long attachments on the weather-side of the dock. As a wave rolled towards the dock it would run up the caissons and depress them vertically. When depressed their buoyancy would cause them to rise up and roll the wave back again in the direction from whence it came, by these means transforming the kinetic energy of the waves into potential buoyancy stored up in the caissons, which can be usefully given out in reversing the motion of the waves. By this means still water can be secured to leeward of the breakwater for working the dock.

Mr. Halpin, at the request of the Chairman, gave some particulars with reference to the raising of the "Edith" at Holyhead. The "Edith" was a paddle steamer, 250 feet long, 25 feet deep, with 30 feet beam; her gross tonnage was 891, and builder's measurement 1,110 tons. It was not possible in that case to use a continuous lifting machine such as had been described, on account of the paddle-boxes, and the wreck could only be taken hold of at both ends. It therefore became a nice calculation to be sure that she would not break her back on account of the weight of her engines, of 350 horse-power, which were in the centre of the ship. Four large wrought iron tanks were used, braced together with wrought iron girders, and wrought iron hooks $4\frac{1}{2}$ inches in diameter were inserted into the port-holes where they existed in the vessel's side, and made fast by wedging, they were attached to steel wire ropes fastened to the tanks. The tanks were partially sunk and pumped out, and, utilizing the lift of the tide plus the buoyancy due to the pumping, they got the wreck in shore until the cradles rested on her deck. The cradles were then taken away. The ship had been sunk by being cut down almost to the keel by a collision with a sister vessel, but she was patched after being lifted and brought in shore, the water pumped out, and thus floated into dry dock. In that case the necessary attachment holes, besides those already mentioned, consisting of the existing side ports,

were not bored in the way described in the paper, but by an ordinary ratchet brace loaded at one end, the power being obtained by men in the attendant divers' boat, the men in the boat pulling up the weight fastened to the end of the handle of the ratchet brace, which descended by gravity, while the diver only directed the position of the drill and kept it fed up to the ship's side. Enlarged diagrams of the working drawings of the plant actually used were shown by the kind permission of the Council of the Institution of Mechanical Engineers.

Mr. Halpin made a sketch on the black board, shown in Fig. 11, which represents an idea for which he is indebted both to Colonel Cowell and Mr. E. A. Cowper. It consists in carrying a casting on the outside of the tower, which is capable of sliding up and down as well as of slewing partially round (the tower being flush on the outside the necessary joints for bolting the sections together, of which the tower is made up for convenience of carriage on land, being on the inside). This casting carries a gun, which is turned on the outside and fits into the bored hole in the casting; this gun when fired recoils by running back through the hole in the casting and displacing the water in its rear, only slewing the casting partially round on the tower. The gun carries a knife-headed shot, which it is proposed to place close up against the ship's side, and so blow a hole through for the reception of the toggle and steel wire rope attachment for lifting. Fig. 10 shows an idea for which the author is indebted to Admiral Phillimore. It is an arrangement for getting a firm hold of a vessel's side in order to prevent the tower shifting by any means when the operations of making the attachment are going on; it consists of a powerful claw of adjustable length, swivelling in a ring sliding up and down outside the tower. This claw takes hold of the bulwark and so prevents all motion.

Mr. LONGRIDGE, C.E., said he had had the opportunity of carefully examining the models designed by Mr. Halpin, and, as a mechanical problem, had not the slightest doubt of its success. One great advantage was, that they were almost independent within moderate limits of the depth of water. They all knew the difficulty a diver had in working even in 40 or 50 feet of water, but with this apparatus operations could be carried on with perfect success in 200 or 300 feet of water. Wave-motion would not affect the tower, because when it was once resting upon the sea bottom, it might be considered as really screwed into an unyielding solid mass for a great portion of its depth. The motion of water was comparatively slight excepting at the surface; and he was sure that in a depth of 80 or 100 feet, although there might be waves of 12 or 14 feet from crest to hollow on the surface, the tower would be practically at rest. Mr. Halpin had provided for any slight motion that might occur by the way in which he had arranged the boring tool. It was not like a drill, which must be kept in the same position, but by giving it what was termed a drunken motion, it worked a hole through without the slightest strain on the apparatus. The man inside the tower would have nothing whatever to do but to guide the motions of the engine by means of two or three small handles. The use of the electric light was a valuable feature. There could be no difficulty in getting the toggles inserted, and it then became simply a question of lifting power. The dock suggested by Mr. Halpin, besides answering the purpose for which it was more immediately designed, would be extremely valuable to the Navy, as it could be used for a graving-dock, and could go anywhere. Mr. Halpin had provided for every possible contingency, and no doubt could by this method raise an ironclad from a depth of 100 to 150 feet of water at a very moderate expense, putting aside the cost

of the dock, which, as he said, should not be charged to one operation, but could be made useful not only for raising ironclads but for other purposes.

Captain COLOMB asked whether any provision was made against a vertical motion due to the wave-surface increasing the buoyancy.

Mr. HALPIN said that that and also the rise and fall of the tide were provided for by making the top jacket longer, giving a great range of flotation.

Captain COLOMB said he did not quite gather how the water was ejected from the lower jacket.

Mr. HALPIN said a compressor on the tug furnished the power of ejecting the water, for working the engines, and also for blowing away the seaweed.

Mr. WALTER R. BROWNE, Secretary of the Institution of Mechanical Engineers, said that when Mr. Halpin's paper on the raising of the "Edith" was read and discussed at that Institution, allusion was made by two or three speakers to the possibility of applying that or other methods to raise the "Vanguard," and grave doubts were expressed on that subject. He concluded that those doubts must be shared to a still greater degree by the Admiralty, and that, in fact, they must have come to a definite conclusion that the "Vanguard" could not be raised: or else they would have taken some more decided step towards attempting it than was the case at present. Nothing, however, was regarded as impossible by an English engineer as long as he could get the requisite funds; and there was no question but that the "Vanguard" could be raised. If however, the Admiralty were holding back because they thought there was no probability of its being done at a cost that would repay the operation, then he would point out that there really seemed great reason for their carefully considering this plan of Mr. Druitt Halpin's, because the actual expense was comparatively small. Even supposing that the plan was not itself a success, the dock would undoubtedly be an exceedingly valuable and useful appendage to the Navy, quite independently of the particular purpose for which it was designed. The tower, also, if it failed in that particular object, would no doubt be a most useful piece of machinery for submarine operations of almost any kind. It must further be remembered that the "Vanguard" was not the only vessel of the same class which had been, or probably would be, sunk; there was already another lying at the bottom of the English Channel, and the same thing might happen again, especially if in the course of events the great naval Powers of the world should come to blows. He might add that whereas in former wars the English Navy were only able to do one of two things, either sink their enemy's ships or capture them, now, if they were provided with such a means as Mr. Halpin proposed, they could sink them first and capture them afterwards.

Mr. GORMAN (Messrs. Siebe and Gorman) said it had been stated that divers could not work at a greater depth than 40 feet; that was a mistake, for divers belonging to the Admiralty, also those of his own firm, had worked at the raising of the "Eurydice" in 12 to 14 fathoms, and for four hours at a spell, in a strong tide-way. That vessel had been raised, and it was a great credit to Admiral Foley and his Officers. The "Eurydice," however, had taught the Admiralty that raising vessels was a very costly matter; it was a popular sensation to get the vessel up, but it cost more than she was really worth. He believed that the "Vanguard" was lost; a contract had been entered into for raising the "Grosser Kurfurst," but there the difficulty was not so great, for the vessel was resting on a better bottom, at no great depth. His firm were at the present moment engaged with French engineers in constructing a diving dress, and they had taken the lobster as their model. They had had a diver down 180 feet, where he remained for half an hour, and they hoped from alterations they were making, that divers would be able to work at a depth of 200 feet.

The submarine electric light had also been used in England. Some experiments had been made by his firm at Portsmouth for the Admiralty last June, the light was burning under water for about one hour, and gave the greatest satisfaction.

Commander ANSON thought that the lecturer had scarcely realized the difficulties of manœuvring a pillar 200 or 300 feet long in a sea-way, and making proper attachments to it. If the bottom was of mud, or there was any inequality, the tower could not easily be managed, and it would also be extremely difficult to make the

various attachments to it, for with 12 or 14 feet waves at the top, it would be impossible to go near the upper end, because under those circumstances, although the bottom was fixed, the top would be moving about in a most dangerous manner.

Admiral SELWYN said: This is no doubt a most interesting question, for ships are increasingly liable to be sunk, and as yet we have not succeeded in any very great measure in raising them again to the surface. Probably, as in former days, we shall find "prevention better than cure," and the means of keeping ships from being sunk will be much better worth studying than how to get them from the bottom after they have been sunk, especially as men-of-war have a tendency to fight in deep water, where it would be as utterly hopeless to attempt to raise them again as it is to raise the forgotten anchors and specie at the bottom of the Spanish main. I wish, however, to ask one or two questions. I do not understand how many toggles the lecturer proposes to employ, and what weight is to be put on each. We have here to deal with half-inch iron plate, and I doubt whether many tons weight can be trusted safely to the tendency of that half-inch iron not to break out.[1] Then if we divided the weights of an ironclad sufficiently among the steel ropes by boring a large number of holes, that line of holes along the whole ship will go a long way towards cutting her in two, and in the case of a vessel which has become filled with mud or sand, it is very doubtful whether the whole bottom would not come off were an attempt is made to lift the top. We know that none of our heavily armoured ironclads could stand slewing many feet without the upper part of the vessel crushing in the lower; they could not be supported on the keel, but must be water-borne or supported by struts carefully disposed over a large portion of the surface. The next point is as to the mode of expelling water. We are dealing with a tube 200 feet long, which has been sunk by the admission of water, and that water is to be expelled by forcing in air; 200 feet depth, means 90 lbs. on the square inch, a very heavy pressure to deal with, especially when it has to done from on board a tug, and by means of flexible tubes. I should like to know something more of the process before I should be satisfied that it would prove effectual. Then there is the point of how ventilation is to be secured at the bottom of a shaft of that depth. With regard to the dock, Sir Edward Belcher many years ago proposed a floating dock which was to accompany a fleet all over the world. There is not much difference between Mr. Halpin's dock and any other, except that it is so made that it would be very awkward to steer or to tow. It might possibly be made of a more sea-going character by being constructed as two separate vessels to be joined together when required. I do not see the smallest difficulty in lifting any vessel from the bottom of the water at a moderate depth and in a moderately protected situation; but the difficulties increase in proportion to the depth and disturbance of the sea. Any idea of manœuvring a tube 200 feet long, with waves running 15 feet high above the mean level, which is about the effect of a gale of wind, is perfectly impracticable. We must wait for calm weather, which will involve being always close to the spot. If the ship is sunk close to land she could readily be approached when fine weather commenced; but in the case of the "Vanguard," a considerable time will be occupied in reaching the spot, and by that time the weather may have changed. I am very glad to hear Messrs. Siebe and Gorman say they have so far conquered the difficulties of pressure as to get divers to the depth spoken of, for I would rather see a dozen men working each in a diving dress than one man confined in a tube and trying to do what would occupy him necessarily a very long time, for it is quite clear that many days would elapse before a sufficient number of holes could be bored in that way. This is not a subject which can be dismissed in an evening's lecture as accomplished, but it is one on which we ought to thank everybody who comes forward as the lecturer has done to give his experience under certain circumstances which will I hope at least lead us to a better understanding of the whole question.

Mr. MORLEY said that he should like to be allowed to make one observation with reference to a remark that fell from Admiral Selwyn as to the evil results of an ironclad grounding and slewing five or six feet. He was present when Her Majesty's

[1] A tube 200 feet long by 4 feet diameter has a buoyancy of 71 tons, and its weight, if of half-inch iron, would be about 30 tons.—J. H. S.

ship "Neptune," then the "Independencia," designed by Mr. Reed for the Brazilian Government, was ashore off Greenwich, and at low water he walked down to within a few feet of the vessel's side. He was also present subsequently when the ship was docked at Chatham Dockyard, and sights were taken both longitudinally and transversely, which showed that she had not suffered by the accident.

Admiral SELWYN: Was it on soft mud that she grounded?

Mr. MORLEY: No, on hard shingle.

The CHAIRMAN said though there might be some difference of opinion as to the possibility of lifting the "Vanguard," there could be no difference of opinion as to their indebtedness to Mr. Druitt Halpin for coming and delivering that lecture. Mr. Halpin had already attained great fame as a civil engineer by the way in which he lifted the "Edith" after a very influential body had given it up as almost impossible. He tried it and succeeded; and what was of itself a very great merit, he estimated the cost of his experiment quite correctly before doing it. He begged, on behalf of the Institution, to return Mr. Halpin their best thanks.

Captain COLOMB said he should like to say one word with reference to the point raised by Admiral Selwyn as to the danger of crushing up the ironclad from the superincumbent weight of plating, and so on. When the "Audacious" was at Hong Kong, the dock authorities pumped the water out of the dock, allowing the ship simply to rest upon bilge blocks. He was horrified at what they had done, but found it had no effect whatever upon the ship. There was no sign of any strain, although she was left for perhaps an hour with very little water in the dock, and resting almost entirely on the bilge blocks.

Mr. HALPIN in reply said an ironclad in the present position of the "Vanguard" had lost one-fourth of its weight by submersion. The weight of all the water in the boilers disappeared, all the woodwork ceased to give weight, even if it did not positively give flotation, the coal in the bunkers only retain about 10 per cent. of its original weight, and one-seventh of the weight of all the iron in the ship ceased to exist. This would reduce the weight of the "Vanguard" from about 4,000 tons when she sank to about 3,000 tons in her present position. He had docked over 500 ships in the way described, and had never seen the copper wrinkle even on the most cranky old timber ships. He had never seen any trouble with iron ships by their being docked in the manner shown.

Admiral SELWYN said he referred exclusively to heavily weighted ironclads.

Mr. HALPIN said he should not fear to dock an ironclad on the system shown there, especially in the light of experience gained by the "Independencia" when she was in a very much worse position—lying on a hard shingle beach at Greenwich unsupported by any blocking, as shown in his plan. The number of attachments proposed to be used in a ship of that kind was 100, 50 on each side. No doubt it would cut away a good deal of the ship, but that it would let the bottom out he could not see, because as a matter of calculation the remaining iron would be quite strong enough to carry a very much greater weight. The actual strain on the iron would be less than 1 ton per square inch; the Government allowed the railway bridges to carry a load of 5 tons per square inch. In the case of the "Edith," where they really only had ½-inch plates to deal with, they found by having an exact representation of a piece of the ship's side made and put in the testing machine, that they were perfectly safe with a strain of 30 tons on a hook 4¼ inches in diameter. In his present proposal he had made all allowance for sand and mud; in fact, assuming the vessel to weigh 3,200 tons, he had allowed for an additional 7,000 tons of mud. They then had only 100 tons on each attachment, and with 1¼-inch plate and toggles of that nature, they had sufficiently large bearing area to make it safe. The ropes would break at 250 tons. Then as to expelling the water from the annular jackets surrounding the tower, 90 lbs. was referred to as an unmanageable pressure to work with in compressing air. He knew that air required different treatment when put under pressure than water. Water would be put under pressure up to several tons on the square inch, but air was at the present day readily compressed to 1 ton, at which pressure the Government were now successfully using it for torpedoes, and he should not be in the least afraid of dealing with a pressure of 90 lbs. Mr. Gorman stated that they had worked at 180 feet, and they must have the same pressure on the pipes; yet it was their boast that they had never lost

a man through a pipe bursting. The ventilation was very easily arranged, because the man could let fresh air in from the pipe supplying the lower jacket whenever he felt it getting hot, and, in fact, could keep himself as cool as he liked. Reference had been made to Admiral Belcher's dock, and a comparison drawn between that dock and the dock now proposed. But there was this difference. In the first place, Admiral Belcher's dock was perfectly incapable of raising wrecks, and, in the second place, it was designed to raise a ship of only 6,000 tons—the largest then known. The weight of the dock itself to lift 6,000 tons was 16,000 tons, while the weight of the proposed dock, which was to lift 10,000 tons, was 3,300. He (Mr. Halpin) calculated that with two pairs of 150 horse-power engines the dock would steam ten knots an hour, the engines then probably indicating about 1,200 horse-power. Admiral Belcher's calculation showed that his dock, owing to its enormous beam, would require about 12,000 horse-power to drive it at eight knots per hour; and, as to his dock being unmanageable at sea, he had yet to learn why a twin screw should be less manageable than a dock like Admiral Belcher's with only one screw. In fact, it was one of the features of his dock that he could place it anywhere over a wreck, and work with one set of engines or both. The objection had also been made that from the position of the "Vanguard," and the necessity of having fine weather to work in, it was hopeless to carry on any attempt at lifting. He could not agree with that view. The "Vanguard" was within three hours ordinary steaming of Kingstown, and by watching the weather they could always get out. Then, if bad weather came on, the ower could be put in safety in a very few minutes by making it float horizontally when they could easily tow it into harbour. None of the work would be undone; a light-ship would be placed over the wreck, and the labour would not be lost. As to rather seeing divers making holes than having them made in the way proposed, he asked how long, supposing the "Vanguard" to be in dry dock, it would take 100 mechanics to make attachments which would enable her to be lifted bodily out of dock. As a rule divers were not mechanics, they were sailors, and masons, and men of all sorts of occupations; but very seldom engineers or boiler makers. In reply to Captain Colomb, Mr. Halpin said the cost of the dock would be about 80,000*l.* to lift 10,000 tons, and the cost of the tower, and allowing a month's tug hire to make the experiment of seeing whether such an attachment could be made, would be about 2,000*l.*

LECTURE.

Friday, January 24, 1879.

ADMIRAL A. P. RYDER IN THE CHAIR.

THE RELATIVE IMPORTANCE OF "BROADSIDE" AND "END-ON" FIRE FROM SHIPS OF WAR TACTICALLY CONSIDERED.

By Vice-Admiral G. G. RANDOLPH, C.B.

PREVIOUS to the application of steam to ships of war the value of end on, and especially of bow fire, was unquestioned, and the amount with which ships were furnished was limited only by the space available and consideration of seaworthy and sailing qualities.

When steam was introduced the view was, I believe, still unchanged, and, although it is true that the paddle wheel necessitated the removal of the armament from the centre to the extremes, yet it was seen that, from the manœuvres now rendered possible, if not, indeed, necessary, this so far from being a disadvantage was a positive gain, permitting the adoption of much heavier guns than were ever before thought of for use at sea.

So much was this the case that one of the greatest objections raised against the screw propeller was the interference which it caused with the heavy stern gun.

The subsequent introduction of armour did not, in any way that I am aware of, change these views, and when the turret was proposed, one of its principal advantages was considered to consist in its capacity for all round fire.

Nevertheless, a different view appears lately to have arisen, and has been brought forward with much force, going so far as to reject end on fire as a mistake altogether, on the ground of its comparative inaccuracy and involving, if armour protected, additional weight to be carried.

Perhaps the question of its importance relative to the broadside, *i.e.*, whether any sacrifice of the latter for the sake of the former, and,

if any, what proportion is desirable, may not have been generally or sufficiently considered.

I propose, therefore, with great diffidence, to offer some reflections on the subject, and endeavour to bring it forward from a point of view which shall bring theory and practice into the closest relationship.

We all know that in this, as in all matters of practical seamanship, which defy the mathematician, theory unconfirmed by experience cannot be relied upon, and as naval architects must depend upon naval Officers for this confirmation, it seems of some importance that the subject should be well considered by the latter, and that public expression should be given to their conclusions.

I am also in hopes that the consideration of the tactics which I shall introduce may prove useful, even in their very defects, by suggesting their improvement, and extracting their corrections from some of the many members of the profession whose capacity and experience so greatly exceed my own, and so much better qualify them for forming sound opinions on the subject.

I shall not dwell on the well known various duties of our ships in naval war, but it is necessary to remark, for some people require to be reminded of it, that whilst they will be the same in principle as of yore, viz., defence, not defiance, still that defence cannot be passive for the simple reason that, if so, England would be reduced to the position of a besieged city, which, so defended, must ultimately surrender under starvation. It must be aggressive as heretofore, but that aggression will be carried out very differently.

Naval operations will hardly at all resemble those of former wars, and the difference materially affects the question under discussion.

There will be no cruizing of frigates to capture others convoying rich merchant ships; no Spanish galleons to intercept; no chivalrous challenges of ship by ship; our trade will be in great part self-protected by its steam and speed. But fast and light ships will keep the police of the sea, to whom any number of hostile "Alabamas" will only afford exciting occupation and welcome prize-money. To these ships no one will deny the necessity of long range chase guns.

It is to the ironclads that the controversy, if controversy there be, applies, and to these I shall therefore confine myself.

These ships will, I apprehend, operate generally in squadrons or groups, smaller or larger.

The larger, *i.e.*, fleets, will deal with those of the enemy very differently from formerly: for instead of being safe inside many or most of their harbours, and kept in by blockade, they will be subject to attacks from which neither ordinary batteries or torpedoes will protect them, and other operations, whether purely naval or combined with military, will be undertaken which could not have been attempted in the olden time, and which will bring our ships into collision far more frequently than formerly with shore batteries and ships at anchor.

It is of no use to contend that our Navy's duty is to beat that of the enemy, and should confine itself to its own element, should not mix

itself up with military operations, or run its head against stone walls. It has never been able so to limit itself; witness, Copenhagen, Algiers, Acre, Sebastopol, Cronstadt, &c., &c., and it will be still less able or willing to do so in future. Can it be said that if the enemy's fleet stays at home ours must be inactive? Must it not, rather, will it not most certainly, undertake every possible operation to damage or weaken the enemy? Nay, not only the possible, but even the impossible (according to the rule of cold blood), as it has often before done.

Although ironclads will, I believe, generally act in groups, they may occasionally meet in single combat, especially on distant stations; and as the relative strength of squadrons can only be estimated by comparison of the individual ships, I propose to discuss, in the first place, an imaginary engagement between two, alike in all respects except that one has and the other has not end-on fire.

I take for my illustration the medium size of the "Audacious" class, and the following assumpta, as reasonable in round numbers:—

Armament, 12 similar guns.
Full speed, 11 knots.
Half speed, 6 ditto.
Radius of turning circle at full speed, 300 yards, time, 5′.
Ditto, ditto at half speed, 200 yards, time, 10′.
Rapidity of fire, one round per minute.
Limit of training to broadside guns, 35°.
A represents ship with all-round fire.
B ditto, ditto broadside only.
B then has 6 broadside guns.

A has only 5 ditto, but the after gun trains to right astern, and a bow gun from right ahead to 55° towards the beam.

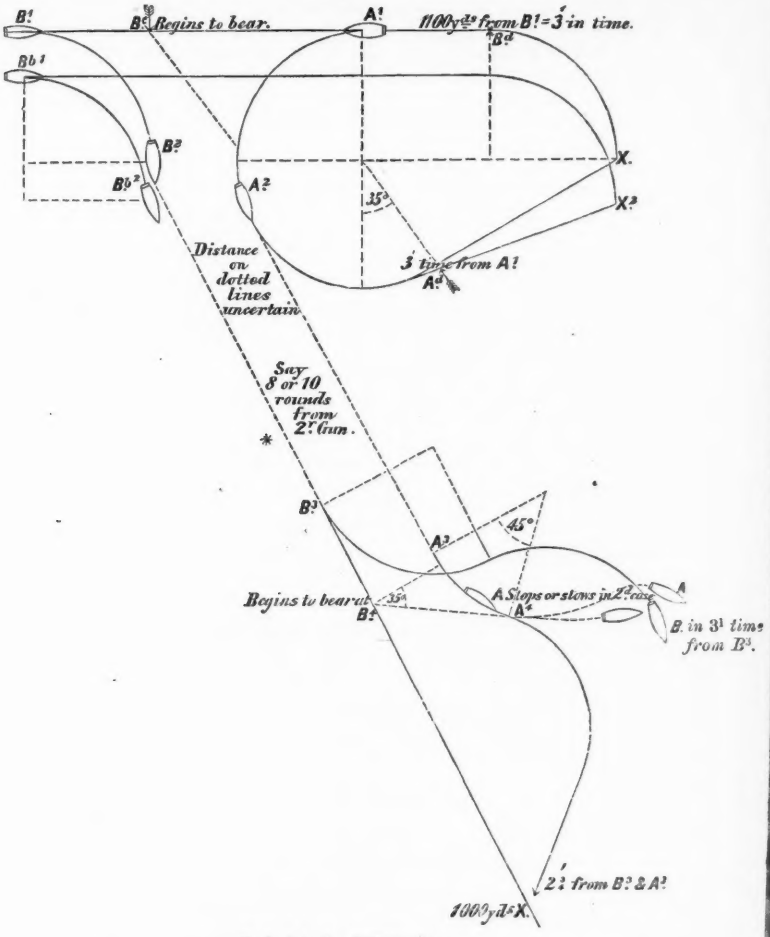
I limit the latter to 55°, and also forego the power of the foremost broadside gun, training as it now does, I believe, to right ahead, because in the close action to be described these guns could hardly be available in both directions, although they might be so at intervals of separation, and would certainly be so in many engagements of a different description.

The Fight.

The rival ships sight each other one morning; let it be a fine one, with all circumstances favourable for accurate manœuvring. Eager for the fray they steer full speed right at each other. But B believes in his broadside, plus, no doubt, his ram. A believes in his ram, plus, his broadside, plus, his end-on fire.

B's tactic is to pass close and give such a broadside as, a few times repeated, will give his foe his *quietus*. But A does not see it in the same light. He is not foolhardy enough to court immolation by ramming at 22 knots, therefore, before arriving within the radius of danger from his contemplated evolution, he turns suddenly in order to bring on the engagement illustrated in Fig. 1, in which his evolution commences at the point A^1, 800 yards from B.

FIG. 1.



Scale ¼-inch = 100 yards.

If B turns immediately to follow him he will, on completing his first quadrant at B^2, find A (to whom I allow for his initiative a start of about a ship's length) at A^2, who having delivered his starboard broadside, may now steady his helm and continue to keep B on his quarter, with impunity to himself, and a gun bearing upon his foe, so

* It would probably be so many minutes before B abandoned hope of coming up with A.

long as B pursues him. Let us first suppose that he does so for 8′ or 10′, when having done some mischief to his opponent, A at the point A^3 sheers off four points of the compass, and then back again towards his enemy. B rushes up to deliver his impatient broadside, which A having received, nearly end-on, shakes off with more or less pain, which he forgets in the prospect of ramming, now presented to him at the point X, where he will arrive simultaneously with B in $2\frac{3}{4}'$ from the point A^3.

But suppose B acts otherwise, and at any time before or after reaching B^3, sheers off (to starboard will not do, because, though he might deliver his port broadside, he would have no further game) to port across A's wake, firing his starboard broadside. A then consoles himself with the same prospect as before, he "slows" until B is before his beam, and then has a chance to ram; if he fails in effecting it, he passes across B's wake, delivers his starboard broadside, and keeps on B's port quarter long enough to give a second broadside, and afterwards bow fire *ad infinitum*.

Here let it be remarked that when B previously crossed A's wake, he had not this game before him. He had neither the chance to ram nor to pass as close, and even if he had, he could not keep on A's quarter with the same impunity and advantage.

Now let us go back to the beginning and assume that B adopts quite a different tactic, and instead of turning after A, he proceeds straight on.

He will then arrive at B^d when A is at A^d in 3′ time. If he continues his course, A can only pursue keeping up bow fire; but if he attempts to turn across A's bows, the latter has the chance to ram at X.

Now let us investigate the comparative fire delivered by each in the three foregoing cases:—

First case.

B commencing at B^4, fires in 2′ time, 2 rounds—12 shot

A fires starboard broadside	5	shot
„ starboard quarter uncertain, No. say	8	„
„ port stern gun	1	„
„ starboard broadside	5	„
„ port bow gun	1	„
Total	20	} *versus* 12
+ Chance to ram		

Second case.

B fires possibly, though improbably, 2 rounds—12 shot

A fires starboard broadside	5	shot
„ starboard quarter uncertain	x	„
„ port broadside	5	„
+ chance of ram		
And if ram fails A fires starboard broadside	5	„
A fires probably second ditto	5	„
starboard bow	x	„
Total	$20+2x$	} *versus* 12
+ chance to ram		

Third case.

B fires, in 2′ up to B^3, 2 rounds	12	shot
If he tries to cross A's bows, 1 round	6	„
Total.....	18	
A fires starboard broadside	5	shot
„ port ditto.....	5	„
„ 2 bow guns	2	„
Total.....	12	*versus* 18
+ chance to ram.....		

Now, let us suppose that at the beginning the ships did not steer direct at each other, but so as to pass 100 yards apart; and let A act as before, crossing B's bow.

The engagement would differ only as follows:—B*b* might possibly, in the two first cases at Bb^3, obtain a port broadside at his enemy at A^2 (an illustration, be it remarked in passing, of the value of extreme promptitude of action). In the third case, the range would be closer, and A would have to ease his helm sooner to prevent B crossing his bow, or to effect his ram at X^2.

Now, before passing to other phases of the fight, I would recall to mind that the effect of fire is not to be measured by the number of shots, or even hits; but is greatly dependent on the distance, position, and size of the target (the material of the latter and skill of the artillery men being supposed equal). Now the size alone of the end-on target, presented by a ship, is generally less than one-fifth of that of the broadside. The shape is almost (may I not say quite) impenetrable to ordinary ships' guns with the armour now worn, and though the depth is, on the other hand, five times as great, this is of little practical importance within the point blank or low trajectory ranges under discussion.

To estimate the difference of effect between a shot striking a ship's side perpendicularly, or nearly so, and another striking her end-on target, is such a pure speculation that I can expect no concurrence of opinion upon it.

Experiment or science may tell the difference between two shots striking a plain surface at different angles, but I do not know that a correct comparison can be drawn between the effects on the various curves of which ships' extremes are formed. But I reason thus.

The one target is approximately five times the size of the other. If it be said that the smaller is so large that in these days of skilful gunnery most of the shots will hit. Theory may say so, and perhaps quote some harbour practice in support, but experience must say nay, at least until our hits in cold blood target practice at sea exceed that proportion of the shots fired that the practice target bears to a ship's cross section. It is, of course, absurd to suppose that the hits in action will be anything the least approaching to those in target practice, but that does not affect my comparison which refers to theoretical possibilities.

I think, then, I shall be well within bounds in expecting three hits

at the side to one aimed at the extremes, and that considering the chances of entering a port it is impossible to put a less value upon each broadside hit than three times that of an end-on one, making a total proportionate effective value of six to one for shots at the broadside. But here we must make a very considerable set off for the increased effect of an end-on shot passing just over the armour, as well as the danger to screw or rudder insufficiently protected; for this I will give back three to one, and fix my relative effective value as low as three to one in favour of shots aimed at the side. But now comes the difficulty of drawing a line distinguishing what may be considered a side and what an end-on target. Would it be a fair compromise to draw it at 45° from the beam? Perhaps so, but it is very open to doubt from the irregular shapes of bows and quarters, nor is it perhaps possible to draw it accurately, but I must make an attempt, and the best shot I can make at it is to draw it so that all shots received from outside the bearing of broadside guns, that is, 35° from the beam, shall be considered as effective for one-third only of those received from within that bearing. Now let us apply this correction to the artillery results we arrived at in the foregoing three cases:—

First case.

B fires 2 rounds, not subject to corr.	.....	12 shot
A fires starboard side, 5 rounds, — corr.	=	$1\frac{2}{3}$
„ starboard quarter, uncertain, but put at 8, — corr.	=	$2\frac{2}{3}$
„ port stern gun, no corr.	.....	1
„ starboard broadside, ditto.	.....	5
„ port bow gun, ditto	.....	1
Effective value.	.....	$11\frac{1}{3}$ } *versus* 12 shot
+ chance of ram	.....	}

Second case.

B fires starboard side, 6, — corr.	=	2
Possibly ditto, ditto	.....	2
Effective value.	.....	4

A fires starboard side, 5, — corr.	=	$1\frac{2}{3}$
„ starboard quarter, uncertain.	.....	x
„ port side, 5, no corr.	.....	5
+ chance to ram, or		
„ starboard side, 2 rnds., 10, —corr.	=	$3\frac{1}{3}$
„ starboard bow, uncertain	.....	x
Effective value.	.....	$10+2x$ } *versus* 4
+ chance to ram	.....	}

Third case.

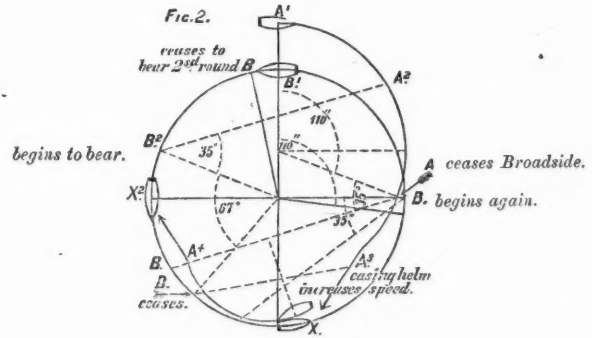
B fires 6 shot, — corr.	=	2
„ 6 ditto, no corr.	.....	6
And if he crosses A's bows at risk of being rammed, 6, — corr.	=	2
Effective value.	.....	10

A fires starboard side, 5, — corr.	=	$1\frac{2}{3}$
„ port side, 5, no corr.		5
„ 2 bow guns, no corr.		2
Effective value.....		$8\frac{2}{3}$ } *versus* 10
+ chance to ram.....		

Here let me remark that although the value of x cannot be defined, it may be considered certainly as a positive, not a negative quantity, and one that may be of great value, much depending upon the skill of your opponent.

Respecting the value of the chances to ram, each gentleman must attach his own estimate to it; some will probably think that a good chance is worth any amount of disproportion in artillery power; others will put a different scale of value upon it; but all, I think, will admit that it must be a factor of immense weight in estimating the attack and the merit of the different moves made with that object in the game of tactics.

FIG. 2.



Scale $\frac{1}{4}$-inch = 100 yards.

But the comparison is not yet complete, for the different ranges have to be considered.

When the ships' broadsides mutually bear the range is of course the same, though we must remember that B fires 6 to A's 5 guns. But it will be found that in almost all A's positions, when not exposed to B's fire, he is at the closest ranges.

We will now recommence the struggle on a different principle, and in future will continue to apply the same correction for the effective value of the fire.

Let A accept B's assumed attack and the ships pass, exchanging broadsides at 100 yards. *Vide* Fig. 2.

B turns from A, and the latter turns across B's wake. It will be

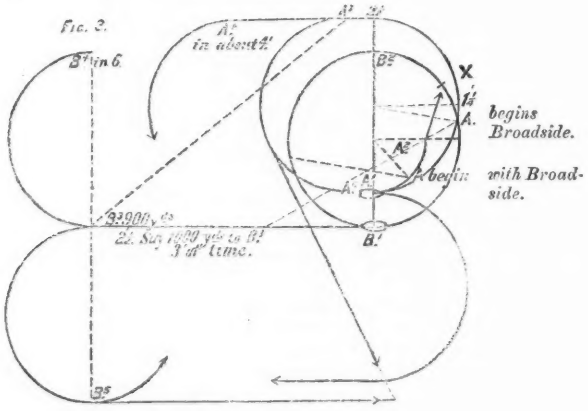
seen that A, on arriving at A^3, obtains a chance to ram at X, unless B sheers off, and, further, that if fails he may then, by going half-speed for $\frac{1}{4}$ of a circle, *i.e.*, to A^4, have a second chance should B continue endeavouring to approach him.

The exchange of fire in this case will be as follows:

B bears through 67°, after first passing, and fires starboard and port broadsides, no corr.		12 shot
A fires 2 starboard broadsides	10 shot	
„ port bow, — corr.	= $\frac{1}{3}$	
Effective value	$10\frac{1}{3}$	*versus* 12
+ chance to ram		
And if the ram fails		
B fires further through 110°, no corr.		12
Effective value		24
A fires port broadside, no corr.	5	
„ starboard ditto ditto	5	
	10	
Effective value	$20\frac{1}{3}$	*versus* 24
Plus 2 chances to ram		

If B in either case eases his helm and sheers off, A has power to cross his wake and continue the fight, as in Fig. 1.

We must now go back to the first exchange of broadsides, and suppose B adopts the contrary manœuvre and turns across A's wake, as in Fig. 3.



Scale $\frac{1}{6}$-inch = 100 yards.

Perhaps A's best manœuvre would be to turn to meet him, *i.e.*, to port, but at half speed, and on arriving at A^2 by the time B was at B^2, have a chance of ramming at X, unless B sheered off, when A would follow.

During this manœuvre B would bear upon him through 180°, or $2\frac{1}{2}'$ of time, and fire possibly $2\frac{1}{2}$ rounds, or 15 shots, *i.e.*:—

6, no corr.....	6
9, − corr.....	3
Whilst Effective value....	9
A fires starboard side, 5, no corr.....	5
,, port side, 2 rounds, no corr....	10
,, starboard bow gun, − corr. =	$\frac{1}{3}$
Effective value.....	$15\frac{1}{3}$ *versus* 9

But B may adopt neither of the foregoing moves attributed to him, and proceed straight, with the object of getting out of range, and danger of ram, before turning. Now A can turn either way, say first to port, and when his half circle is completed in $2\frac{1}{2}'$, finding B still going straight, he steadies his helm. B proceeds, say nearly 3′, or 900 to 1,000 yards, and at B^3 turns to starboard, arriving at B^4 in about 6′ from the crossing. A being at A^3 when B began to turn, could ease his speed a little and manœuvre, as in Fig. 1, if B continued to approach; or, if B at B^3 should turn to port, A would do likewise, and, before arriving at A^5, when B would be at B^5, be in advantageous position to bear down, threatening to ram, or keep on his enemy's port bow should he proceed straight.

Now, if A's first move had been to turn to starboard instead of to port, the relative position would have been one or other of those described, according to which way B turned at B^3. The fire in this case has been as follows:—

B fired starboard side, 6, no corr.	6
,, ditto, ditto, − corr. =	2
Effective value.....	8
A fired starboard side, 5, no corr. ..	5
,, port 5, − corr. =	$1\frac{2}{3}$
,, bow guns, 2 rounds—or 3 shot, no corr.	3
,, starboard broadside, − corr. =	$1\frac{2}{3}$
Effective value.....	$11\frac{1}{3}$ *versus* 8

We pass now to consider the case of one ship crossing the path of the other at right angles, *vide* Fig. 4.

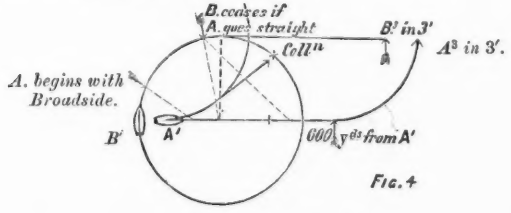


FIG. 4

Scale $\frac{1}{6}$-inch = 100 yards.

Let B cross A's stern at 100 yards, and, after pouring in his broadside, port his helm, in order to continue a broadside engagement.

A has various courses open to him; let us consider three:—

(1.) If desirous of obtaining a ram at the expense of a second broadside, he may "slow" considerably for a minute or so, until B gets before his beam, when he has his chance at X, if B continues his circle or tries to cross his bows.

(2.) He may turn to port at once and cross B's bows, deliver his port broadside, and afterwards keep up stern or quarter fire.

(3.) He may proceed straight on, say for 600 to 1,000 yards, in order to avoid B's second broadside, and then turn to port, crossing B's bows, if that ship has followed him, and if B starboards to avoid it, and get his own broadside to bear, A can keep on his quarter, maintaining a fire from his port bow gun. Now to B's alternatives:—

If he had gone on straight, in the first instance, or after making his first quadrant, A might have kept on his quarter, firing his port bow gun, and if, in the third case, B had continued his circle, and thus passed across A's stern a second time, he would have no further good prospect.

The comparative fire in these foregoing three cases is as follows:—

(1) B will bear perhaps for one minute after his first broadside and thus deliver 2 rounds, or 6, − corr. = 2
Ditto, no corr. 6

Effective value..... 8

A fires on B's approach starboard side, 4, − corr. = $1\frac{1}{3}$
" " stern, 2, no corr. 2
" " port side, 4, no corr..... 4
" " bow gun, 1, no corr..... 1

Effective value..... $8\frac{1}{3}$ *versus* 8

(2) B fires starboard side, 6, − corr. = 2
A fires as before, starboard, 4, − corr. = $1\frac{1}{3}$
" " stern, 2, no corr. 2
" " port, 4, no corr. 4
" " qr. fire, − corr. = $2x$

3

Effective value..... $7+2x$ *versus* 2

3

(3) B fires as in case 2..... 2
A fires as before, starboard side, 4, − corr. = $1\frac{1}{3}$
" " stern guns, no corr. 2
" " 2 broadsides in 2′ up to point A^3, less 1 gun, 9, − corr. = 3

Effective value..... $6\frac{1}{3}$ *versus* 2

Let us now see the result of the same tactics, the ship exchanging positions, *i.e.*, A crosses B's stern. In such case the fire would be:—

(1)	B would fire, on A's approach, starboard side, 6, — corr.	=	2
	„ „ port side, no corr.		6
	Effective value		8
	A, on approaching 2 bow, no corr.		2
	„ „ starboard side, 4, — corr.	=	1⅓
	„ „ „ 5, no corr.		5
	„ „ port bow, 1, no corr.		1
	Effective value		9⅓ *versus* 8
(2)	B as before, case 1		8
	A as before, case 1		9⅓ *versus* 8
(3)	B fires starboard side, 6, — corr.	=	2
	„ port side, 6, no corr.		6
	„ „ 6, — corr.		2
	Effective value		10
	A fires 2 bow, no corr.		2
	„ starboard side, — corr.	=	1⅓
	„ 2 bow guns, 2 rounds each, no corr.		4
	Effective value		7⅓ *versus* 10

Now it will be observed that when A crosses B's stern, he has some moves open to him, which are not so advantageous to B in the same situation. He could in the first case (*i.e.*, if B stops), on completing his first quadrant, steady his helm, and keep B under fire of his quarter gun. In the second case, *i.e.*, if B turns to port, A might turn at half speed to starboard for a quarter circle, *vide* Fig. 5,

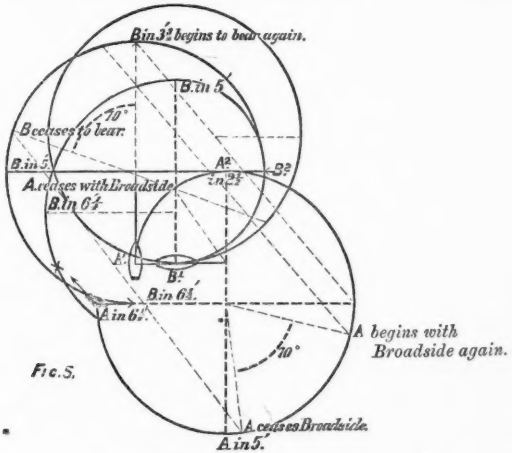


FIG. 5.

Scale ¼-inch = 100 yards.

and if B continues to turn at full speed, await his return to B¹, and keep on his bow with his stern or quarter guns bearing; but if B

reduced his speed, A, by resuming full speed at A^2, would have a chance to ram at X.

I mention this chiefly as another illustration of the extreme importance of prompt initiative, and rapid execution of evolutions, for the diagram will show that if B goes slowly for only one quadrant, he will complete his circle first, and A cannot ram, whereas, if he slows for half the circle, A will be able to do so on the supposition that he has himself resumed full speed after the first quarter circle. This, of course, equally demonstrates one of the many advantages of superior turning power. From this digression let us return to the artillery result of the last tactic.

B would fire starboard side, 6 — corr. =	2
„ port side, 6, no corr.	6
„ „ „	6
Effective value.....	14

A 2 bow, no corr.....	2
Starboard side, 4, — corr. =	$1\frac{1}{3}$
Both bows, 2, no corr.....	2
Port side, less 1, 4, — corr.	$1\frac{1}{3}$
Stern, 2, no corr.....	2
Starboard side, 4, no corr.....	4
Effective value	$12\frac{2}{3}$
+ Chance of ram.	} *versus* 14

Our next case shall suppose one ship failing or declining to ram, crosses the other's wake at an angle of 45°, Fig. 6. Let A do

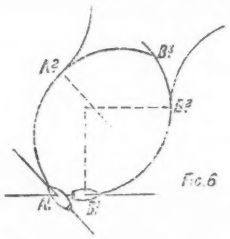


Fig. 6

Scale $\frac{1}{8}$-inch = 100 yards.

so; he has received B's broadside on his feather edge, and now delivers his own at close quarters, and both ships turn towards each other. B would arrive at B^3 before A could do so, and would, therefore, have the power to cross his bows, or by easing his speed at B^2 have a chance to ram; but A has the power of avoiding this by starboarding across B's bows. If these positions are exchanged, B could do likewise, but with this difference, that A can maintain a station on B's bows and a fire which the latter could not in the same circumstances. The artillery result here is:—

B fires starboard side, 6, — corr. =	2
„ port ditto, no corr.	6
Effective value.....	8

A fires starboard, 5, no corr..... 5
" " " 5
Quarter fire, — corr. = $\frac{2x}{3}$

Effective value..... $10+\frac{2x}{3}$ *versus* 8

The case of crossing at an angle of 45° from the course, instead of the wake, has been considered in Fig. 1, and if A crosses B's bows at this angle, he turns naturally to the same course, keeping up his fire from quarter gun with impunity—a tactic not open with advantage to B in the same position.

There are, of course, a great variety of other phases which such a combat as I have sketched may assume, and, no doubt, tactics much better applicable to those discussed, but I think the foregoing sufficient to illustrate my view, and enable dissentients to controvert it or induce waverers to prosecute the investigation further. It is obvious that practice will be found to differ widely from the theories propounded. In the first place, ships do not turn in such perfect circles, especially in the first quadrant; secondly, ships cannot act as simultaneously, or nearly so, as has been assumed; thirdly, not even an approximation to such precision, such celerity, can be realised in battle; and, fourthly, it may be objected that my estimate of the effective value of shot is purely arbitrary and good for nothing. I admit all this and much more, but I know no better way of arriving at a good opinion than by first ascertaining theoretical possibilities or probabilities, and then setting off such corrections as experience or practice may show to be necessary.

The deviations from true circles will probably balance each other. Alterations, due to the initiative of either ship, must be allowed for; and as to my estimate of the effective relative value of hits, I admit it is arbitrary and may be very wide of the mark; but no one will deny that there is an enormous difference in the effect of shot striking different parts and at different angles, and my rough shot at a comparison will not be worthless if it may elicit a better from anybody.

Before quitting the single combat, I must anticipate the remark that I have done the broadside ship injustice by not giving her as much credit for the use of her ram as the "all round" ship, while she has equal power to use it effectively. It might, perhaps, be sufficient to reply by the question—If she does so, what becomes of her broadside superiority? But I must also deny that she can use her ram with equal power, for want of supporting it by artillery fire; and if it be said you could not use both because your smoke would prevent your effecting your ram, I reply that this may be the case sometimes, but very far from always, as when waiting, or manœuvring for the opportunity, or at a distance, or with a wind that shall remove this impediment.

In the foregoing manœuvres I have not introduced any turnings performed with stern way, because, though they would not unfrequently be very usefully effected, yet it is not possible accurately to

foresee, still less to describe, their effect, but it must be observed that, in so far as they are used in aid of the ram, the two opponents are equal, but when their object becomes to obtain artillery fire, A has the advantage in its use, because it will only serve B through an arc of 140°, and A through the whole 360°.

Squadrons.

It has been observed that hostile squadrons or fleets will have to be dealt with very differently from formerly; not only will they be attacked in situations where they could not have been reached before the days of steam, but when met at sea an entirely different tactic must be adopted.

The end aimed at will be the same, but almost every means will be different.

Breaking the line, the vaunted triumphant manœuvre of Rodney, which formerly might be supposed to throw the lee portion of the ruptured mass out of the fight for the day, will now be in itself good for nothing. The power to rake your enemy is shorn of its former extreme value; and even the object of manœuvring entirely changed, inasmuch as it was formerly to get your broadside to bear at most advantage, whereas I submit that the object of ironclads, against whom artillery is comparatively so weak, must be to ram. If this be so, it appears to me to necessitate a tactic different from that formerly and still in use.

I think it will be granted that the true art in a naval as well as a military battle is to throw a preponderating force upon some important point of your enemy's position or line; be it the centre to separate the wings, or a wing to turn his flank, or otherwise, as it were to break his backbone, and deal with the mutilated body afterwards.

That it is not scientific or good tactic to throw your whole force headlong into collision with your enemy, shades of Nelson forgive me! and I discard the idea sometimes advanced of fleets rushing into action at 10 or 11 knots in line ahead and close order, which I consider suicide and fratricide combined, for if it requires the utmost vigilance in ordinary evolutions to keep clear of each other, when your second ahead is bound to warn you of every intended change before it occurs, how would it be possible to avoid rolling each other up in action undertaken in this manner?

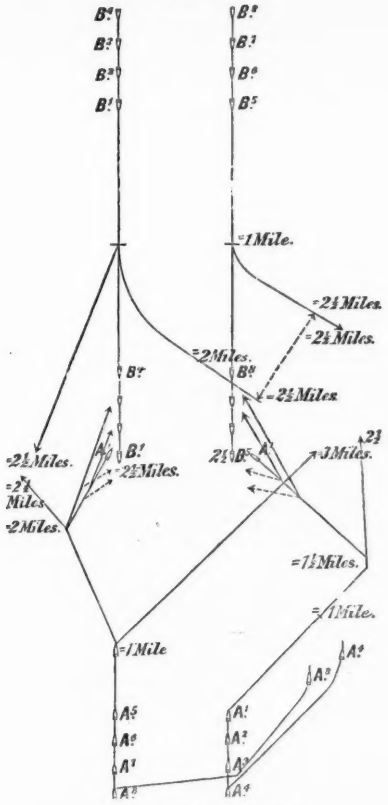
I do not, either, believe in there being any danger, but quite the reverse, in dividing your force within certain limits, but rather that it will often be necessary, and almost always desirable.

I proceed to sketch an imaginary engagement between two squadrons, composed respectively of A's and B's, and say eight in number, convenient for sub-divisions.

They sight and approach each other, formed in two columns of divisions in line ahead, either close or open order. *Vide* Fig. 7.

On arriving at about four miles from B, A's starboard division alters course in succession, say four points to starboard, taking open order. Its port division "slows" very much to let the other get away about

FIG. 7.



Scale $\frac{1}{12}$-inch = 200 yards.

a mile, and then proceeds on a course two points to port of the original one.

Each division drops one ship (or the port division a sub-division) which forms a reserve, in echelon, in rear of the advanced division, in order to keep out of the beginning of the fight; to give assistance where most necessary; to consummate the anticipated victory, &c., and also with a further object which will appear presently.

Meanwhile B may be supposed, whilst endeavouring to make out A's manœuvres, to have advanced, say a mile, before changing his course.

First suppose he does not change it; then A's starboard division having gone a mile, or a mile and a half, resumes in succession its

original course, with a view to bear down upon B's port division at an angle of about 45°, intending to let the leader pass with a broadside or two, and attack directly the three, or even only two, rear ships. Meanwhile A's port division, a mile in the rear, prepares to make a similar attack upon B's starboard division, if it continues its original course.

It will be observed B's two leaders are suffered to pass with only a broadside from one or perhaps two ships, but they are still threatened by the reserve.

Now whether that reserve should attack them or not may be open to question, and depend, perhaps, on circumstances such as the comparative force of the ships, or other and ulterior considerations; but if passive they would at least embarrass the enemy, and prevent the two leaders returning to the support of their friends. Their most useful rôle would probably still be to give the *coup de grâce* to a somewhat crippled enemy, or support to a somewhat overpowered friend, and if the two hostile leaders were suffered to escape, ambition should be satisfied with the capture or destruction of six out of eight.

But now to B's alternative moves.

Suppose, on seeing A's change of course, he alters his own with a view to attack A's starboard division now so temptingly separated from the other.

A's starboard division might proceed on the original course, cross the bows of B's starboard division, and attack his port division on their starboard sides, whilst A's port division, on observing B's change of course, would turn in succession or together upon B's starboard division.

But A's starboard division has the option of abandoning his original prey, and by turning to port, suddenly combine with his other division to crush B's starboard division before the port could arrive to interfere.

Or A's starboard division might continue to threaten and engage, the rear at least of, B's port division, detaching his rear ship, or the reserve, or both, to complete the destruction of B's starboard division.

Such a tactic on the part of A has, to my mind, an additional recommendation that the different attacks, not being simultaneous, would be attended with the least risk of the ships doing injury to each other.

Now let us see the value of broadside fire against such an attack.

It is clear that A^1 (*vide* Diagram) would receive the broadside of B^5 before grappling B^6.[1]

A^2 could hardly receive a broadside, unless the order was extremely open, before fastening upon B^7.

A^3 might, perhaps, receive B^5's second broadside, but no other B ship would fire an effective broadside. Now reverse the case and let B make a similar attack upon A.

So far as the ram goes it would be equally effective, but our concern is with the artillery.

Now each of B's ships, on his attack upon his opponent, would be

[1] Numerals mean Fleet Nos.

exposed to additional fire from the ship ahead and astern of that opponent.

But still more. If each ship's ram was a perfect success the fight is at an end; but this supposition is Utopian, and it is in the confusion and partial failure resulting from the first assault, that it appears to me end-on fire becomes invaluable. The A's, after missing their prey, reverse their course, the divisions turning outward from each other, and bear down again upon their disorganized enemy in various directions, and at moderate or slow speed watch for every opportunity for a shot, whilst pointing themselves for a decisive ram. If B occupies himself meanwhile in bringing his broadside to bear, he plays into his adversary's hand.

Supposing that B had, in the first instance, separated his divisions, and detached the starboard one to attack A's port division, the tactic of the latter would be the same as that suggested for the starboard division, with this important difference, that the reserve might bear down in its support and so place B between Scylla and Charybdis.

Now, I submit that in this, or any other attack made on the principle of ramming, wheresoever that object is attained at an angle exceeding 35° from the beam of B his broadside is absolutely useless; and that in other cases exactly in proportion to the use he may make of it will be A's better chance to ram, and also more powerful the effect of his bow fire, because it will have the weaker target. I would also observe that if there be any utility in the part which I have assigned to the reserve it would not be performed with equal advantage by ships without bow fire.

We pass now to the attack upon forts or ships at anchor.

It may be considered that the best method of attacking forts is to pass and repass in a circle at various distances to disconcert the enemy's range, but this must depend upon the locality (at Sebastopol it could only be done at an useless range), and it may be assumed that almost anywhere ships can approach cautiously end on, nearer than otherwise, and by dropping a kedge, with or without a spring remain there.

I believe that an end-on fire could be maintained very much longer and more efficiently by a given number of bow guns, than by double or treble the number of broadside ones, and with a tithe of the risk of damage to the ships. They might vary their distance to and fro by a cable's length or more, by merely hauling or veering upon their hawsers. They might relieve each other every two or three hours, and the crews of the guns engaged as often as required. Nay, I believe that such an attack would often be the only possible or prudent one, and the B's are incapable of it.

Squadrons or fleets of ironclads must not, I presume, be supposed to be blockaded in their ports, but carefully watched for their sortie.

For this purpose it would sometimes be best to station a portion of the "observation" squadron on each side of the entrance, connected by a line of small, fast signal vessels. In such case, attack upon ships coming out might necessarily be made from two or more directions, and it is not easy to see how the blockaders are to get their opportunity

for using their broadsides with any advantage, or how the blockaded are to obtain any advantage from having a gun or two more on their broadside and none at their extremes.

But suppose either squadron to be caught at anchor. How much worse would be the position of the B's than that of the A's, either for attack or defence? In a roadstead, with little or no tide, the B's might be attacked and even rammed without a chance of firing a broadside or even a single gun, or take an attack in a tide like the River Tagus. The A's, anchored by the stern if on the flood tide, might keep up a heavy fire until slack water, or the enemy's springs gave them an opportunity to ram.

The familiar operations of forcing the passage of a river, defended by forts, so well illustrated in the late American War, only require to be mentioned in support of end-on fire, but it may not be superfluous to add the by no means unfrequent case of a ship on shore. The "Tiger" had to succumb to a few field pieces; and conceive your feelings when a little insolent wasp of a gunboat may take up a position of impunity and sting you, it may easily be, to death.

There are many other positions in which a ship may be little less helpless or useless, as where the swell or other causes prevent her presenting her broadside; and I have seen on several occasions, good and most effectual service done by the end-on fire of paddle steamers on the coast of Spain, when no ship could have shown her broadside, in fact, ships present were powerless.

Now I know there are some, and I hope many, who, far from requiring any demonstration of the value of this armament, never doubted it, but still have the question open as to how far it is justifiable to sacrifice broadside power for it? and what additional weight to be carried is it worth?

It has been estimated that for such ships as we have been discussing, 100 tons of additional armour would be required for the end-on protection.

Well, is this anything very formidable for a ship of 6,000 tons? I am no naval architect, and cannot tell what increase of dimensions or cost would give this additional buoyancy, but I imagine any architect would smile at the question, and if I am forbidden by my hypothesis of absolute equality from adopting this resource, I would abandon my position and accept defeat to that extent, if necessary. But I cannot doubt that it might be met by a reduction in small proportion of armour in height or at the extremes. Weight of water, provisions, and stores, even to coals, if necessary (though I would abandon the latter with reluctance), but all depending very much on the service in prospect.

Respecting the sacrifice of broadside fire, I think the clear net result of my illustrations is that out of six guns not only can one be spared without loss, but with absolute gain, and when I remember that the foremost broadside gun now trains to right ahead, and might still continue to do so, I cannot doubt that every ship of ten, *i.e.*, five broadside guns, should have one on each side, *i.e.*, two to fire right ahead, and a ship of twelve guns should have a second on each side,

capable of being used in either direction, and a ship with a more numerous battery at least four for bow fire, all having two to fire right astern.

Had my typical ship of twelve guns been so armed, the proportionate addition to her effective fire in some of the foregoing cases would have been very great, and in one case nearly double.

For example:—At page 41, referring to Fig. 4, the effective value would have been

$$\left.\begin{matrix}15\frac{1}{3}\\ \text{instead of } 11\frac{1}{3}\end{matrix}\right\} \textit{versus } 8.$$

At page 43, referring to Fig. 5, when A crosses B's stern, the effective value of his fire in the first case would have been

$$\left.\begin{matrix}12\frac{1}{3}\\ \text{instead of } 9\frac{1}{3}\end{matrix}\right\} \textit{versus } 8.$$

And in the 3rd case as much as

$$\left.\begin{matrix}13\frac{1}{3}\\ \text{instead of } 7\frac{1}{3}\end{matrix}\right\} \textit{versus } 10.$$

And at page 44, referring to Fig. 6, the effective value would have been

$$\left.\begin{matrix}16\frac{2}{3}\\ \text{instead of } 12\frac{2}{3}\end{matrix}\right\} + \text{chance to ram } \textit{versus } 14.$$

I have no wish to depreciate broadside fire, but I cannot think that it will be possible to enforce such an engagement upon an enemy, unless more stolid than we have any right to expect, nor justifiable to attempt it unless your superiority in this respect is so great as to seem decisive in itself. Nor can I adopt the faith which seems prevalent that actions must be begun, still less continued, by exchanging broadsides. I sympathize with the delight of blowing targets into smithereens by these concentrated *coups*, but they seem, after frequent repetition, to leave a sort of photographic impression on the mind, picturing the approach of the enemy, expressing the rapturous excitement of the firm heart and glowing eye, awaiting the moment when, without even a word or gesture of command—

> A finger's pressure, nothing more,
> The pond'rous cannons thundering roar;
> A passing cloud of smoke, and lo!
> The waves engulf the haughty foe.

It is a pleasing dream, but dreams, they say, sometimes come true. Let this be one of them, and what then? I fear it must rapidly dissolve into a nightmare, for the logical consequence is that the dreamer must either go down with his foe, or at best have a fearful struggle for dear life, for if this is to be the consequence of the six-gun broadside, how much less is to be that of the five-gun reply.

Not a large margin of comfort for our awakened dreamer. In all seriousness I feel sure that these broadside attacks will be rare because false tactics. I say false, because the true one for ironclad rams must be the ram, not recklessly, or at fearful speed, or without reference to

consequences from other foes hovering about, or other considerations, but to manœuvre with this view, and when you fail to ram, it may be intentionally, it affords the best means of using your artillery. If you succeed in ramming, enough; if you do not you deliver your fire at closest quarters, and receive that of your enemy with most impunity.

But I object further to concentrated broadsides against ships at sea, unless under extremely exceptional circumstances.

I mean no disparagement whatever to, or want of all reasonable confidence in, the talented and experienced Officer, whoever he be, who is to direct the fire, but I hold that, as a rule, subject like all others to exception, it will be a wicked waste of opportunity not to fire a gun when it bears certainly upon your enemy, and that if a second bears, it is a crime to keep the two waiting for a third, and so on. It will, of course, be replied that no such thing was ever contemplated, and that it was only for the first moment of the enemy coming under fire that it was intended.

Well, I might, perhaps, be satisfied with this admission, for it is a very large part of my contention, but I am not.

I still refuse to trust my whole power under such supreme circumstances to my skilful Officer, who being after all only mortal, has but one pair of eyes, which can never equal those of five or six or more times the number belonging to men who have had, as a rule, ten times the practice in firing for prizes at a target, and are selected as captains of guns for their tried and proven proficiency. Nor is this all.

I do not presume to pass judgment on the reliability of electricity. If infallibility be claimed for it, I am in no position to dispute it. But it must not only exist, but every commanding Officer must have that implicit faith in it which I don't think has been yet arrived at, before he will be justified in trusting to it.

I submit then that naval actions will not in future be decided by the broadside. It will play a most important part, and may sometimes even be decisive, but if so, that result will hardly be due to some small superiority in that respect.

It will be skill in manœuvre. The sharp intelligent eye to discover, and the ready presence of mind to command, and the perfect discipline to execute the right movement at the right time, which will decide the day. When these are found superior on the side of the broadsides, they will prevail in spite of their disadvantage, just as a pugilist may in a fight, with one arm tied behind him, but it is giving long odds to the adversary.

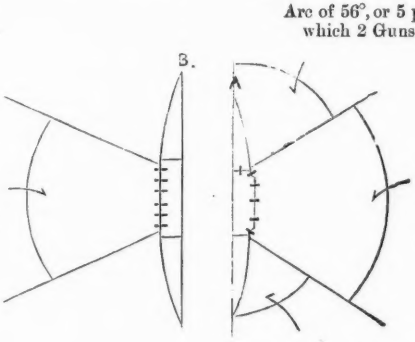
Whatever opinions may be formed on the views I have ventured to advance, I trust that their investigation may be useful in eliciting their correction, and will serve to bring into high relief the vast advantage of superior manœuvring power in ships, and especially the importance of the promptest execution of every evolution. They will also point a most serious moral.

The days are gone by when a Captain had only to put his ship within range of his enemy and leave the rest to his Officers and crew.

There is no position that history assists me to conceive, in which so much, comparatively, will depend upon the personal qualification of one Officer, as that of a Captain in such combats as these we have been discussing, and must look forward to; and does it not forcibly show the supreme importance of each Officer, who aspires to such a position, studying thoroughly the subject and being prepared to act instantly and unhesitatingly, by having at his finger's ends, the moves of sound tactics and their consequences, with reference to those which are, under the circumstances, possible to the enemy?

Theory may point out and even decide what these moves should be, but practice alone can make experts in their execution. As our Officers were formerly thus perfected in seamanship, so may our young ones in future in increasing numbers, and by unremitting pains and constant practice in innumerable small vessels, be rendered equally masters in handling their ships, not only singly, but in squadrons; and by a due appreciation of the vast responsibilities which may devolve upon them, nothing less than the guardianship of the very destinies of our country, be urged to strain every nerve to qualify themselves for so important, so noble a position.

The CHAIRMAN: In asking you to discuss the very interesting and instructive paper Admiral Randolph has read to us, I must request you to endeavour to confine the discussion strictly to the two real points at issue. First. The best tactics for two different vessels and two differently armed fleets to pursue before and after the action has commenced, and what grows out of it, the best way of distributing any given number of guns, in an amount of say ten or twelve heavy guns. The Admiral has raised the important question as to the relative values of "end-on" and "broadside" fire, or to put it more correctly, having end-on fire and not having end-on fire. This is a narrow and very important issue, and to enable you to follow it more


Arc of 56°, or 5 points, within which 2 Guns bear.
B.
Arc of 70°, or 6 points, within which 6 Guns bear.
Arc of 70°, or say 6 points, within which 5 Guns bear, though not all simultaneously.
Arc of 56°, or 5 points, within which 1 Gun bears.

distinctly, he has given us a ship A (of which I suppose he advocates the armament) which has one gun forward pointing right ahead, and which cannot be trained on to the broadside. The gun next to it can be trained ahead and also on the broadside.

Then there are four broadside guns and there is one gun on the quarter which can also be trained right astern. That is the nature of the armament he advocates, and he has assumed that there will be somebody here who will take up the B position, and advocate it as the better way of distributing that number of guns, viz., by putting these six guns as a broadside and not allowing either one to train right forward.

Admiral RANDOLPH: I by no means mean to advocate ship A: it is no representative of my *beau ideal* of a ship. I only wish to illustrate the tactical difference between a ship of that kind and the other.

The CHAIRMAN: Admiral Randolph has in his mind a still better ship than A, which we may hear of some day, but still he wishes you to consider whether A or B is the better ship for evolutions, and that is the point to which I hope peakers will confine themselves.

Admiral Sir COOPER KEY: We must all, I am sure, recognise the importance of reducing this question to accurate discussion, such as we have listened to in the paper which has been read. I have frequently heard this question conversed about; but I have never seen it so accurately discussed as has been the case this afternoon. I am afraid that naval Officers are not, as a rule, given to the accurate consideration of these questions; and we must acknowledge that it would be difficult to introduce a matter of this kind before a public assembly for discussion in a clearer manner than that which has been adopted. I cannot call myself an advocate either of A or B's mode of armament, and therefore I will give, without reference to the diagrams, my own opinions on the point. We heard some few years ago, Officers frequently advocating the importance of "end-on fire" as against fire from the broadside; and I have heard Officers insist on the advantage of opening fire on approaching the enemy from their guns. They have said that they would, if they could, always keep their bow towards the enemy; for the end-on bow fire was the most important fire that could be brought to bear. Now in contradistinction to that view, I am decidedly an advocate for the use of broadside armament. In the first place the more guns you can bring to bear, the better; but also the great disadvantage of end-on fire is this—you must be in rapid motion. You are changing your distances constantly, and so is your antagonist. You have no certainty of what your accurate distance is; and I am therefore satisfied that when you are approaching an enemy end-on, your fire will be thrown away; whereas, when you can bring your broadside to bear, your own distance is not altering, and you can judge your distance with far more certainty than you can whilst approaching end-on, besides being able to bring the greater power of your ship to bear on the enemy. But although I strongly advocate bringing your broadside to bear whenever it is practicable, yet I should not recommend a ship being armed only on the broadside. It may happen that your steering power or your motive power becomes disabled, and then you must resort to bow or stern fire. There are also occasions in narrow waters in rivers—or the vicinity of shoals, and with your ship placed in various positions when bow and stern fire is of great importance: therefore, I should never think of advocating the arming of ships so that they could not fire in every direction round the horizon; that is, having one or two guns bearing on every point of the compass. Notwithstanding this, however, I am an advocate, as I say, for bringing your broadside to bear whenever you can. I cannot attempt to follow the Admiral through his interesting engagements. I will leave that to others; but I must observe that although he has been as impartial as human nature will allow, still if I were an advocate of the broadside armament only against his own views, I do not think I should like him to fight my ship: I would rather let him fight ship A, and let me fight ship B; for there are various cases in which he has pointed out what the manœuvres of B would be which I do not think I would follow. For instance, you see at A^4, (Fig. 1), the ship is "stopped" or "slowed." Now, I consider that that stopping or slowing would be a deadly sin; for if I were in the position of B^3, passing across his stern, I should have a choice of three modes in which to punish him. I would rather ram him in the stern and disable his steering gear or screw; or I would pass slowly across his stern and give him one or two broadsides before he could gather way; or if I did not do that, I would range up in his quarter and give him a Whitehead torpedo. In that case you would have a beauti-

ful opportunity of sinking your enemy. I am only pointing this out to show that in order to have this thoroughly discussed, you ought to have the "war game" carried out, the advocate of one principle fighting the one ship, and the advocate of the other principle fighting the other ship. In the same way I may refer to the squadron manœuvre, Fig. 7. If I were commanding the B squadron, and Admiral Randolph had separated his two divisions, I think he would have acted injudiciously. I cannot think it is the right principle to divide your squadrons in that way; certainly the object which you should have in view is to bring a preponderating force to bear on a portion of the enemy; but I think the Admiral would be defeating his own object. Take for instance, the case where your starboard division has gone to starboard a mile and a half. If I, commanding squadron B, saw that manœuvre, and saw the port division a little on the starboard bow of my starboard division, I would then alter course and take my whole squadron to starboard, close the columns, and so bring his port division between my two columns and give him both broadsides; thus his small division of four ships would have to stand both broadsides of the eight ships, and I think some of his ships would by that time be slightly disabled, when the starboard division might be similarly treated.

Admiral RANDOLPH: Will you go back to the time when you would alter your course in the B Squadron?

Sir COOPER KEY: Just before your starboard squadron got in that position marked "a mile and a half."

Admiral RANDOLPH: Having first altered its course to port.

Sir COOPER KEY: Before it altered the course to port. When I saw him as far off as possible, I would endeavour to leave him there, and then go down on the other column; and if I could get at one column between my two, I think I could make an example of it. I should like to say one word as to firing by electricity. The Admiral appears to connect firing by electricity only with the concentrated broadside, and no doubt it is often so considered. I consider one advantage of firing by electricity to be that you have to depend on one careful and experienced Officer who has probably had far more experience in firing at sea than any of the captains of the guns. He is placed in a position away from the gun deck, and where he can see the enemy at all times when a view from the ports is obscured by smoke; he is in a protected tower, or some position which would insure his seeing the enemy and taking aim with the "director;" so that at any time, as long as they are paying attention to loading below, he can always fire at the enemy with certainty. Generally speaking, we choose a smooth day for target practice; and fire by electricity is not of so much importance in smooth water as in a swell. If there is the slightest motion, it is almost impossible to fire your guns at the right moment, except by electricity. The fact is the men cannot see the object out of the ports; they are so constantly obscured by smoke; and I am quite certain that if we can give the Officer an opportunity of firing from the upper deck, it will be of the greatest importance, for in doing so he has an advantage which the man on the gun deck has not. I do not see why we should fear that the electric arrangements will get out of order. I have had considerable experience in the matter in my two last flag ships; and although we had on one occasion early in the commission, bad tubes, still, when we got better tubes, I never knew them fail, and the more we practise with that system the more advantage it will be to us, and the more perfect we shall get in its use. There is no reason why it should break down any more than the electric telegraph does, so long as our people are thoroughly accustomed to its practice.

With reference to bringing the fire of ships to bear against forts, I cannot agree with Admiral Randolph that it would be better to attack forts end-on. If you are at a distance where you require, say, three or four degrees of elevation, we know that the difficulty of hitting an object is not in the *direction*, but in the elevation for range. Whether it is due to defective eye-sight, or to the want of accuracy of the gun, the deviation in range is far greater than the deviation in direction. You have got, I contend, four reasons for putting your ship *broadside-on* to a fort. In the first place you get all your guns to bear. You then give the fort three difficulties with regard to pointing, which have to be overcome. The fort does not know your exact distance; and by giving him 50 feet to fire at instead of 300, you render

the difficulty of hitting six times greater. The accuracy of the gun is also defective in the same way for, as I have said, the defect in range is much greater than in direction; and, thirdly, although the fort knows your direction accurately, it does not know your distance. Therefore, if I were engaging forts at a distance, I should, as I have on two occasions, advisedly place gunboats and ships broadside on to the fort, as I know the chance of hitting on the broadside is less. If you are close to a fort with ironclads, I say also, give them your broadside; you may be certain, *cæteris paribus*, that three guns will always overpower two. The additional gun is an advantage which you ought not to forego for any reason whatever.

Captain COLOMB: I have reason to believe that I had the honour, and I may say the success, of, I won't say initiating, but at any rate putting into Admiral Randolph's mind the design of this paper. I am in the position that Admiral Cooper Key asked for, and that is, I am a B. I have long been a B, and as I understand Admiral Randolph, it is a passage in one of my papers which he has come to-day to discuss. With your permission I will just read the one or two sentences to which I think he has referred. I say, "I have already committed myself to the gun up to "the moderate weight of 25 tons, and I have already claimed its disposition on this "broadside as the best. To me it is an astonishing question which is commonly put, "'whether is the bow or the broadside the most important fire?' because I have "never heard a serious argument in favour of the bow-fire. I know that an opinion "in its favour exists, or is supposed to exist, because in a great number of ships, the "broadside is weakened, and very many terrible inconveniences and dangers submitted "to in order to supply bow-fire. But I have only heard it asserted in support of this "policy, that as a ship must not expose herself to be rammed, she must be prepared "to fight an end-on battle. But unless she is pretty close to her enemy, and in a par-"ticular relative position, there is no objection in life to her presenting her broadside, "and an end-on battle must become a broadside one after the lapse of a very few "minutes." Then I go on to observe that finally, summing up the whole question, I throw over the end-on fire in favour of the broadside fire, but I say, "I have no "objection to a light end-on fire as an adjunct to the heavy broadside fire, and I "think that if the foremost and after guns of my heavy broadside battery can bear "a little more forward and after training than the others, it will not be amiss, "provided it does not detract from the ordinary broadside power." Now, the whole question, as I put it, is the amount of sacrifice that you are prepared to undergo for the purpose of securing your end-on fire. I have said also that my enemy, if I met him, must either fly from me or allow me to get my broadside to bear. Taking the question of the sacrifice that you have to make for end-on fire, I think Admiral Randolph does not put it as high as it really is. In a ship I quoted, to which I think he has referred, the sacrifice was 100 tons, when the whole of the gun power, ammunition and everything combined, was only 400 tons. Therefore, you might have added 25 per cent. to your gun power if you had foregone your end-on fire. I think if you will recall Admiral Randolph's figures you will see that he does not quite admit that sacrifice.

I cannot help expressing my satisfaction at the method that Admiral Randolph has adopted. We have never had, that I remember, in this Institution, a paper in which accuracy of method has been pursued to such an extreme, and I am quite certain the whole meeting agrees with Admiral Cooper Key that it is by such methods alone that we shall, in time of peace, arrive at anything like the truth. Admiral Randolph has naturally taken the duel as his main point, because as a matter of fact a very little investigation shows us that the duel is most favourable to the use of end-on fire. The corrections for shot which the Admiral has given us require very much closer thought and investigation than can be given in an open discussion in this theatre, but as the general effect of his paper on my mind, I gather that upon the whole stern-fire in the duel is likely to prove more important than bow-fire, and I find other Officers have come to that conclusion on different data. In considering the question of the duel, I, as a B, would have taken an entirely different method of beginning the action from that which has been set down to me. I have considered that in the duel, B would think almost entirely of his ram,—that he would hardly use his guns at all except on the failure of his ram. Now, I fail to see in B's manœuvres, as detailed by Admiral Randolph, that he has had in

his mind this leading idea of the ram. Instead of B advancing end-on towards A, as is shown in Fig. 1, B would, from my point of view, the moment he sighted A, bring him four points on his bow. That was what I set out in 1872,[1] in a paper read before this Institution on the attack and defence of fleets. I came to the conclusion that supposing we were dealing with two equally willing adversaries, that would be B's tactics, to bring the other four points on his bow, and it seemed to me that would oblige A to do the same thing,—that he could only approach by bringing B four points on his bow,—that the two ships would then draw together under conditions where the broadsides of each, and not the end-on fire, would become most valuable. Now, I think I detect in that diagram that B, even advancing as he has done, has a chance of ramming before A^1 reaches A^2 which he would, I think, having the idea of remaining in his mind, proceed to put in operation. It seems to me that he has here exactly the opportunity that he wants. Now B having the idea of his ram, and only his ram, would of all things avoid the position given him on A's starboard quarter. The very most he would do, if he found himself in that position, would be to deliver one or two broadsides, yawing, and therefore allowing the distance between himself and A to increase; because all through, his great idea would be to get A again and again on to the four points bearing, with the view of employing his ram upon him, the four points bearing being that most advantageous for converting your advance into a ramming attack. I think I see at B^1 that the Admiral has hardly been fair to the broadside ship. I think if A, after she had stopped and slowed, were to go down towards X, as she advanced B would starboard the helm, and would get the advantage she was looking for.

Admiral RANDOLPH: It is a mistake to suppose from that diagram that the stopping was meant for A on that occasion. It is meant for the other occasion, as shown by the dotted line, when he puts his helm to starboard.

Captain COLOMB: Quite so, but that does not affect my argument, because we are supposing the ships to have equal speed, and of course B would advance towards X, giving him the opportunity of ramming A, under the influence of her helm. I should like to say one word as to Admiral Randolph's method, which I am sorry he did not follow out. I am sorry that he introduced the reduction of speed, because it is adding an element of uncertainty in the discussion of the question, which makes it just so much the more difficult for B to answer. If the two ships were confined to their full speed, you would have a more accurate notion of what was possible under those conditions, and then after you had decided what was good and what was bad under the conditions of full and equal speed, you might go on to the discussion of differences of speed. In Fig. 2, again, I think that B, having delivered his starboard broadside at A^1, would not, from my point of view, put his helm to starboard. From my point of view, looking to the line he is taking up, he would pass on, so as to get a considerable distance between himself and A^1, and again would come to the four points bearing approach, if he could. In Fig. 6 the advantage is shown on the stern gun, and not on the bow gun of A. While I venture to offer these criticisms, I do so with the greatest possible diffidence. I think every diagram that Admiral Randolph has given us is a subject of study in itself, and I do not think that justice can be done to his ideas without giving a study to each diagram, which I have not had leisure sufficient to do. I hope and feel sure that the members of this Institution, when this paper is published, will see that it is one of the most important papers that has ever been read in this theatre; that they will take up the Admiral's methods, will work out his diagrams, and see for themselves whether they think he is right or wrong. By that kind of criticism we shall get Officers instructed in what are right or wrong movements; we shall get to know more and more the relative advantages and disadvantages of different modes of attack and of armament, and we shall approach more and more to what Admiral Cooper Key suggests as one of the things we want—that is, a Naval War Game.

Captain SCOTT, R.N.: I did not intend to say a word in this discussion, and I should not have done so if the application of electricity for firing guns had not been brough

[1] Vol. xv, No. 64, p. 405; and Vol. xvi, No. 66, p. 1.

forward. So late as last night, while making some experiments with electricity, a break unexpectedly occurred in the current, and I could not ascertain what caused it. I am, therefore, afraid whether in trusting to electrical firing we should not be trusting to what might fail us at a critical moment. The Officer might touch the key of the instrument and expect the guns to go off, but they don't, and so he might lose a valuable opportunity. In that respect I quite agree with what Admiral Randolph has said. As regards the guns, I think it must be apparent that what is wanted is a good all-round fire. A ship which can point her heavy guns so as to fire them in every direction must have a great advantage over another ship which has a powerful fire on the broadside only. When afloat in the Channel Squadron, I observed that the broadside ships frequently could not even keep up a steady fire on their own targets, owing to the small arc of training of their guns ; 35° each way is a very large amount of training, and the greater part of the older broadside vessels' guns have not nearly so much. I think also, supposing you were going to ram a vessel, and perceived that she would avoid you by sheering off, it would be a capital opportunity to fire your guns trained forward into her, whereas if you had to wait until she was abeam before your broadside could bear, she might pass so rapidly as not to give you a good opportunity of firing. There are also many occasions on which guns which will train well forward or aft can be fired with very great accuracy and with such advantage that I think it would be wrong to sacrifice either bow or stern fire. I altogether dissent from the idea of having only light guns to fire ahead or on the bow, for I think a heavy fire on the bow is wanted, and also a powerful stern fire; in fact, a ship should be armed at all points, and such a vessel will on all occasions prove a most formidable opponent. I cannot agree with what Captain Colomb said as to the increased weight of armour required as a protection to bow guns. In fact, if in a ship having 600 tons of armour you were to take off 200 tons, and utilize this weight in guns, you would, I think, get a great advantage. I do not see that you require 100 tons of armour across either the bow or stern, and although you would doubtless be exposed to having your bows fired into, I think you would be far better off with another powerful gun or two there than with an increased weight of armour. My view of the whole case is that our ships carry too great a weight in armour, and too small a weight in guns.

Captain COLOMB: I have not said one word about armour, except this—that to carry your guns under armour would cost you 100 tons more for the simple purpose of getting those guns to bear in the line of keel than it would if you carried them on the broadside.

Captain SCOTT: I do not think that alters the case ; it does not make the armour a necessity, nor can I see that if used it would require 100 tons. The "Nelson" and "Northampton" fire two 18-ton guns ahead; they have very small patches of armour over these—I should say considerably less than 100 tons—to protect both guns, and these fire from ahead to abeam.

Captain BRIDGE, R.N.: I should like to point out what I think is an additional feature in favour of A as against B, if not directly, at all events indirectly, because it tends to weaken the position of B. Captain Colomb, in one of his very able papers, has said that every ship moving through the water "carries on each side of "her a circle of considerable diameter inside of which no power on earth can place "her." Consequently, if another ship is able to get within the circumference of that circle, she is perfectly secure from any attack by the ram of the ship describing it. If we imagine that B is the ship which has one of these circles on either side of her, and A gets within the circumference of either one of them, as long as she remains there she is perfectly secure from any attack of B's ram, and B has only her guns mounted on the broadside, which cannot work beyond an arc of 35°. It is therefore possible for A, placed within that circle, not only to secure herself against the ram of B, but to be perfectly secure against the fire of B's guns. In addition to that, as Admiral Sir Cooper Key has alluded to the Whitehead torpedo, it seems that the most disadvantageous position from which the Whitehead torpedo can be discharged is from the bow ahead or nearly right ahead. There is also another point in favour of A. A is in a position to use her quarter guns, but she cannot be rammed by B, she cannot be struck by B's shot, and the chances are very much against her being touched by B's torpedo. There is this other advantage of a ship

so armed, of all the time being able to use her own guns. I admit of what I am going to say that it is only a slight one, but still it is an advantage. In a paper written some time ago by Commander Grenfell, the question of the towing torpedo was investigated. Now whatever value may be given to the towing torpedo by various Officers, I think it will be conceded, that as long as it is used, if we can get into a position where we can be perfectly secure from it, whether it is valuable or not, it is just as well to get there. In that paper Captain Grenfell distinctly proved that if you can get upon the bow of a ship, if you can get within the circumference of B's circle, and on his bow, you are perfectly secure from any danger due to the towing torpedo. There is therefore a position, no doubt a very difficult one to get into, but still there is a possible position, into which a ship provided with end-on fire can get where she can keep up a fire upon her antagonist, and at the same time not be touched by any weapon he has on board.

Captain LONG, R.N.: I quite agree with what Captain Colomb has said about this paper. I feel sure it will be read with great interest and profit in all parts of the world, and for that reason I wish to make one or two remarks about it. I think that these curves are not the practical curves a ship would take. I think the time is too small for the diameter, or else the diameter too great for the time. Therefore, although these pictures are exceedingly valuable to enable us to think about the matter with two ships in relative positions placed upon the paper, I cannot admit that those ships would in reality follow those curves. I wish to point out how it could be brought about that we should be able to follow real curves. We already have the "Thunderer's" turning curves, and that curve can be drawn on a piece of cardboard. Then, as Professor Osborne Reynolds, in a paper he read before the British Association, remarked, "After M. Froude's late discoveries, it is possible to "make a model of a ship so exactly like her that the behaviour of the model will be "exactly the same as the behaviour of the ship." And it was advocated that every man-of-war should carry one of her boats the exact model of herself, so that the squadron might be manœuvred in its boats, and the relative distances would correspond exactly, according to Mr. Froude's law of comparison. Then as to firing at an angle of 35°, I find by Major Owen's book a shot fired at 1,000 yards normal to the armour would have the same effect as a shot fired at 500 yards at an angle of 35°. I should also like to ask Admiral Randolph whether he prefers his formation to the group formation which has been so much advocated by several Officers.

Admiral PHILLIMORE: One result of this discussion must be that everybody must think that there are certain positions where an end-on fire would be almost invaluable. Whether those positions are very frequent or not, whether the curves are large or small, must depend upon the nature of the screws and the speed at which the ships turn. There must be certain positions where an end-on fire from ahead or astern could be delivered with more effect than the broadside fire, and whether those positions would be often found or seldom found I think it would be extremely unwise ever to do away with the power of firing end-on.

Lieutenant HASTINGS LEES, R.N.: It is with great diffidence that I rise to address this meeting, as, in looking back over my old Journals, I see that no Officer so young as myself has spoken before the Institute: but, as there are one or two points in Admiral Randolph's calculations which he has reduced to mathematical translation, and the result would naturally follow in our minds that his results are perfectly accurate. The Admiral allows one minute per round per gun, which, I think, would not be the case in actual practice, because in the Mediterranean at ordinary target practice in calm weather, we found the average number of broadsides which could be delivered was about twelve per hour. The question of hits was another thing, as to which Admiral Randolph regretted we had no accurate data. In the *Revue Maritime* there is a report of a series of experiments carried out by the Russians and Italians on this very point. Now, the Admiral engages at a distance first of 100 yards. We will presume the ships are at 100 yards, going 10 knots in opposite directions. In that case, according to these experiments, the percentage of hits is 35; that will be when they are coming straightforward on one another. We will now put them in Captain Colomb's direction, the one 45° on the bow of the other, going in the same direction. The percentage is still 35. Now we will put them in the position which Admiral Randolph very often got A into, which was having B on

her bow, A being on B's quarter, and we find the percentage of hits as 23 only. Therefore, to justify Admiral Randolph's calculations, we are to allow 23 per cent. of hits, and to allow you to deliver a projectile per minute, and that everything is perfectly accurate, which I think cannot be the case. There is one other point which relates more to naval architects. I remember the great excitement we were all in in the Mediterranean when we heard the "Temeraire" was commenced, for we heard she was a most perfect ship, that there was hardly any position in which she could not fire. When she came out, we asked her Officers if this was the fact, and they said if they were going 10 knots and there was any sea on at all, their guns were useless. Now Admiral Randolph has supposed a rate of 10 knots, but the Officers of the "Temeraire" said at that speed they would not be able to use the guns if there was any sea. These two points may have some influence on the subject matter of the paper, and I therefore have brought them before the notice of the meeting.

Admiral R. V. HAMILTON: The last speaker stated that 12 rounds an hour was the number of shots fired by the ships at target practice in the Mediterranean. I simply wish to state that 280 rounds were fired by the "Shah" during the fight with the "Huascar" in 2¼ hours, which is considerably more than he states.

Admiral RANDOLPH: How many hits?

Admiral HAMILTON: That is another thing—about 30 altogether. I think it can hardly be expected that you will only fire 12 rounds in an hour.

The CHAIRMAN: Do you mean 280 rounds from the ship?

Admiral HAMILTON: No, 280 shots.

Lieutenant HASTINGS LEES:[1] I wished to say that the average rate of the delivery of the broadsides averaged 12 in the hour.

Admiral HAMILTON: I misunderstood you. In the action of the "Shah" it was 280 rounds in 2¼ hours—that was all I wished to say, except that I cannot conceive a ship in the present day without an all-round fire.

The CHAIRMAN: I have very few observations to offer before I ask Admiral Randolph to reply. I gather that hardly any of the speakers, if they had to design a ship, would give up the end-on fire. That, after all, is the most important question before us. The question of how one of two differently armed ships could engage the other at great advantage, owing to the difference in the distribution of the guns, is a very important question, and it is to that question Admiral Randolph has addressed himself; but to the naval authorities and the Construction Department the far more important question is this: there are ten or twelve 18-ton guns to dispose of for a ship which is about to be *designed*, how are they to be distributed? Are there to be five or six on each broadside and no bow or stern fire, or will you dispose of them so that you will have one gun at least on each side firing right ahead, and one at each side firing right astern, with or without the second gun on each side forward, being able to fire on the broadside and also nearly ahead? I gather from the remarks that have been made, that there is hardly anybody who would deliberately give up in his design, the power of firing right ahead and right astern with armour-piercing guns; Captain Colomb, I think, would.

Captain COLOMB: Pardon me, no. May I explain, in taking the line I did in the Essay, I was bound to take some line and I did it in that way, but I am quite open to conviction. I would not distinctly say I am going to throw over end-on fire in actually designing a ship. I was in this position, that I had to take a line and I have taken that line; I do not mean to say that it is my private thought.

The CHAIRMAN: This, then, appeared to me to be the position in which we are placed. The question as to how you will design a ship, when you have your pencil, compasses, and paper in hand, whether you will or will not give yourself right ahead fire and right astern fire from your heaviest armour-piercing guns, and I think almost everybody who has spoken on the subject, would say that they could not make up their minds to deliberately shut up that fire. Then, having adopted as preferable the "end-on fire" design, as shown by Admiral Randolph in the

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[1] The "Shah's" action confirms Lieutenant Hastings Lees' view about 12 broadsides an hour.

drawing of the ship A, his special question comes before us, viz., what are the best *manœuvres* to be performed by an "end-on fire" ship A, when engaged with a broadside fire ship B, throughout the running fight?—so well illustrated by his diagrams, which diagrams no doubt tend to confirm, in their opinions, those, the large majority I believe, who, on general grounds, will not give up "end-on fire" from the heaviest guns in the battery in any design prepared by them or submitted for their approval. From my own point of view I could not give up end-on fire right ahead and astern; I believe, in many positions, you really must have that fire. Suppose you are chasing your enemy, a ship going your own speed, and though you are within a few hundred yards of her, she chooses to keep on edging away; if you are on the broadside ship B, you will not have a single gun with which you can fire at her, while she being an A, has armour-piercing guns, one at all events, capable of firing on any point, and two right astern—it is a very awkward position for B to be placed in. I rather think after half an hour's engagement B would be dropping astern disabled, owing to her designer having deliberately given up the power of replying to an enemy on her bow or right ahead—the same disadvantage applies to B when being chased. My own view is, that you require at least two armour-piercing guns to fire right ahead and astern if you can provide them.

NOTE.—Whether the heavy guns should be in *box batteries*, or in *revolving turrets*, or on *turntables* in fixed circular batteries, the guns *en barbette*, but vanishing entirely or partially during loading, are very important questions about which there is much difference of opinion, but a decision in favour of either one or other of these does not affect the general principle advanced so strongly by Admiral Randolph, viz., the great importance of *end-on fire*.—A. P. R.

Admiral RANDOLPH: With regard to what you, Sir, have said, I think you are under some misapprehension as to my object and my point. You began by suggesting that I was responsible for the construction of a ship on the principle of A. I have nothing to do with the construction of ships at all, but I take those two with which I wish to bring before you the question of tactics. I do not advocate the construction of A or any other ship, but having such a ship as B proposed by Captain Colomb in his Prize Essay, then, I think, practical tactics will show that there are numbers of positions in which A will have the advantage over B, but I do not advocate the A principle as a *beau ideal* ship, though I do advocate A in preference to B.

I feel it a very great presumption to put my opinions in the least in comparison with the much greater experience of Sir Astley Cooper Key, but perhaps he will permit me to explain that he has misunderstood me, and the difference between us will not be so great after my explanation as it might seem to have been. I think Admiral Key argued that he would engage always with the broadside, because the broadside was the greatest possible fire and was the most powerful fire, and because you could more depend upon the range, and he said that he should engage with his broadside. But, I think, that is rather begging the question. I want to know whether the enemy will accept that engagement; are there not two that must play this game? If you insist upon getting your broadside to bear upon me, am I to be a dummy, am I to be a fixture? Captain Colomb says he should come down at an angle of four points on the bow, and then he says I, A, must also keep him four points upon my bow, and that we must pass broadside to broadside. I submit I will do no such thing, but if he puts himself four points on my bow, I shall simply put my helm to port and run into him. Admiral Sir Cooper Key has, I think, ignored the ram. Now, I do not presume to say that bow fire is better than broadside fire—six guns are better than two—but, I contend, that I should go in for the ram and despise your broadside, and that is the reason I care so little for broadside fire. I go in for the ram, and whilst I am getting my bow pointed and manœuvring with this object, I give you four or five shots from heavy bow guns, whereas B could do no such thing. I do not suppose that the end-on fire is as powerful as the broadside, but I say that I value the ram more than the broadside.

Then, with respect to the attack on forts, Sir Cooper Key says he would attack broadside-on. But there I ask whether it is always possible to do so. For instance, at Sebastopol, in the River Plate, and elsewhere, are there not many localities where you could approach much nearer end-on than you possibly could with the broadside?

Then, as to the inaccuracy of firing from the bow, I apprehend on those occasions you choose fine weather. You cannot make the sea smooth, but you can choose tolerably fine weather in which to attack the forts. Of course, any inaccuracy in the elevation is not of such great importance when you are firing at huge fortifications like Sebastopol and Cronstadt, you do not so much care what elevation you give: if the shot passes the front it may fall into the magazine in the rear, and if your object is to batter down walls, it is no particular matter what part of the wall you strike.

Sir COOPER KEY: My observation was directed to a fort firing at a ship, in which case it was for the advantage of a ship to lie with her broadside on.

Admiral RANDOLPH: I beg pardon, I misunderstood you to that extent. I suppose Sir Cooper Key will admit, when a shot does strike the broadside of a ship, it is ten or twenty times as punishing as if it struck the bow, when it would glance off with impunity: therefore, I would rather receive end-on twenty of his shot on my bow than one on my broadside, taking into consideration the vulnerability of the broadside in comparison. It must be a very accurate shot that hurts me much end-on, but that it would require greater accuracy of elevation from the fort if it were broadside-on than end-on I admit. I did not refer to torpedoes in my paper, because I considered it somewhat irrelevant, and to have entered into the whole subject would have extended my paper beyond the limits assigned. But I quite agree the question ought to be considered as a whole, and perhaps cannot be fully considered without the question of torpedoes being introduced. Ships may be exposed to Whitehead torpedoes from forts, and I consider the end-on position is the safest against that dreadful weapon. I think as between ships, the use of torpedoes would probably be equal on both sides for attack but not so for defence. I think myself, that as A's tactics are everlastingly and perpetually to present his bow, so he is perpetually placing himself in a position of safety from their attack, and, therefore, as to the question of torpedoes, the advantage is on the side of A.

As far as my experience of electricity goes, it has been that it is unreliable: we have heard to-day of bad tubes, and how can we have a guarantee that they will always be good. No doubt, at some periods, the Officer stationed in the maintop may be in a better position to fire from, though not always, than the men on the gun deck, but certainly not in a general *mêlée*, and taking it altogether, I prefer the guns being in charge of the gun captains.

Captain Colomb said I attached more importance to my stern fire than to my bow. I do not think I did so, but if I did I certainly would correct myself. I hold to the principle of the ram, the ram for offence and defence, whether against artillery or torpedo, and, therefore, stern fire is only a valuable auxiliary in my game of tactics to gain that point. Captain Colomb also expressed regret that I introduced the question of reduction of speed, because it threw out the theoretical calculation. But what is the use of the calculation if practically you can set it at nought? You cannot prevent your enemy diminishing speed, and, therefore, you must include it in your reckoning, you must make up your mind for it. And you may not only reduce speed, but, as I have said in my paper, even use stern way on occasions—generally speaking it would be a very dangerous thing to do, but there are occasions when it might be done without danger.

Captain Scott remarked on the 35° training of my gun. I only gave the 35° in order to give the B ship the greatest possible, and much more than I think reasonable, advantage. I also put my estimate of 3 to 1 in favour of broadside hits, believing it to be vastly under the mark, but I did it to make the case as favourable as possible to B. 35° is an extreme training; if it is less, so much the worse for B. Supposing B to be stationary from any cause, you may catch him at anchor, or his engines may be disabled, then, in that case, A steaming round half a circle within 300 yards, would only be under B's fire for one minute, and would receive only one broadside; whereas, changing the position, *vice versâ*, if A is in the same disabled position and B passed round him, B would be under his fire for 2½ minutes; his fire would be only five guns, but he would deliver these with much more time for aim, and certainly would have a chance of firing a second round from his three middle broadside guns.

Captain Long referred to the circles. It appears to me utterly unimportant whether those circles are exact or not, as to whether they are the right dimensions.

I can only say I looked at reports, and I found the "Audacious" and "Invincible," with balanced rudders, completed circles in 4¾ minutes, with a radius one of 200 and the other 163; the "Lord Warden" and "Lord Clyde," in 4·48 and 4·56 minutes, with circles 300 and 316. The "Thunderer" completed her circles in 5½ minutes and 207 yards, an exceptional ship, but I have nothing to do with exceptional ships, I am speaking of general ships.

As to the number of rounds, I put them at one round a minute, but it is no matter what it is, if it is the same on both sides.

After all, it is not much use having the circles accurately described upon paper, because you cannot depend upon them being the same in practice: are our engines always worked at the same pressure? Is coal always of the same quality, and are tubes always equally clean? You cannot depend upon doing things in the same way, you must make allowances, and I guarded myself, by saying that practice must inevitably very much differ from these theories.

Lieutenant Lees quotes some very excellent statistics about 37 per cent. of hits, I should like to ask what the enemy fired in reply, because I do not care very much about this gunnery practice, showing how many rounds you can fire in a minute, or what percentage of hits, unless that target can fire at you in return.

The CHAIRMAN: I am sure you will instruct me to thank Admiral Randolph for his most interesting paper. Although he, for a moment, disputed the statement I made, yet he cannot prevent us who look at it from a slightly different point of view, from trying to think out, by the light of his remarks, how the armaments should be disposed in the ships of the future, as well as of the proper tactics to be pursued by the Captain of A when engaged with B. Admiral Randolph would evidently never design a B himself. We come here, some at least of the older Officers, to listen, and with great interest, to these tactical discussions between the men who will have to fight our future battles, but with the further object of asking the Constructors, what is their view of the matter, what distribution of armament they are going to give us for the future? Therefore, there is over, above, and beyond Admiral Randolph's immediate object, another very practical question growing out of this paper.

NOTE.—There is a paper in our Journal, No. 79, p. 535, showing how the Russians have, for many years, by exercise at ramming, been working out practically for themselves, the great problems—(1), what are the best tactics when two similar ships, or more, are engaged; and its corollary (2), how best to distribute any given number of guns in an ironclad design. Both these problems are studied for several months every year in the Squadron of Instruction in Russia. Several gunboats are fitted with fascinets to prevent injury from ramming, and tournaments are repeatedly held in the presence of the Superior Officers of the Fleet, the Constructors, &c. Each gunboat is manœuvred by the Captain of an ironclad, assisted by one of his Officers and his Chief Engineer. In this way, every Captain in his turn has practical lessons in ramming, and being rammed, or avoiding it, which they could not with safety attempt in their ironclads—and all day long and every day—one or other of the ironclads, taking it in turn, is under weigh, threading her way backwards and forwards through the anchored fleet—the Captain who makes the closest shaves without touching is highly commended—and if he is unfortunate enough to touch one of the anchored ironclads, he may be blamed *as a matter of form*, but I was told he was generally to be found dining with the Admiral that evening. The Russians are a very practical people, and Admiral Boutikof, who has commanded that Squadron of Evolution for the last fifteen years, has brought the science of *teaching* his young Officers what they ought to know, and creating a hearty *esprit de corps* and an *élan*, to perfection. It is to be hoped that a naval "Kriegsspiel" will soon be perfected, but it will not be very useful practically if it is not supplemented by naval tournaments at sea, as in the Russian Navy, in their protected gunboats. These sea tournaments would also throw much light on disputed points in the rule of the road, and settle in a week what the most experienced and practical seamen may go on disputing about for years.—A. P. R.

Friday, February 21, 1879.

ADMIRAL A. P. RYDER in the Chair.

SUPPLEMENT TO LECTURE ON "THE RELATIVE IMPORTANCE OF 'BROADSIDE' AND 'END-ON' FIRE FROM SHIPS OF WAR TACTICALLY CONSIDERED."

WHEN I had the honour of reading my paper on the above subject, on the 24th ultimo, it was justly remarked that it should be considered more fully, or treated more as a whole, that is, as I understood to be meant, that all accessories, such as torpedoes, electric firing, &c., should be included in the treatment of such combats and tactics as I endeavoured to sketch in illustration of my subject.

The limit of time allowed by the rules of the Institution had obliged me to contract the paper; I now, therefore, beg to offer some further observations as a supplement.

The main object of my paper was to demonstrate the value, and, in my own view, indispensability, of bow fire, and the advantage of the bow or ram attack. But I gave myself no time to defend this tactic against that of its opponents, who either estimate its advantage much lower, or its drawbacks much higher, than myself.

Now the principal objection which I have seen advanced against bow-fire, is its inaccuracy as compared with that of the broadside.

There is no doubt of the fact as generally observed in target practice, and the following appear to me to be some of the reasons. Perhaps the greatest of all, whenever it applies at all, may be, what I call the tangential error of the line of sight due to any heel the ship may have, and which at long ranges, that is, with the sight much raised, is very considerable.

But I set this aside as obsolete, or at least inapplicable to ships under steam in moderate weather, such as I suppose battles at sea usually to be fought in; and any error of the same character, caused by rolling motion cannot, I think, much affect the firing of well-trained men accustomed to watch the proper period of the motion for firing, and from guns so close to the midship line of the ship, particularly at ranges when the tangent-sight is hardly raised at all.

Another cause is probably the greater rising and scending motion at the extremes of a ship frequently quicker, more irregular and jerky than the rolling motion.

But I am disposed to attribute the fact much more to the greater difficulty of preserving a steady distance from the target. The inevitable tendency of a ship to forge ahead and approach it, causes the shot to pass over, or if, on the other hand, too much allowance is

made for this recognized circumstance, the shot falls short, and the amount is estimated as greater than that of one falling in reality only the same distance beyond. Moreover, practice is usually made at ranges far exceeding point blank.

But how would any inaccuracy from such a cause affect the fire of a ship attacking another, in such an engagement as I have represented, in which the ranges hardly ever exceed 700 yards, or indeed at any range at which it would be useful to engage an ironclad?

The range can only change by diminishing, and no shot can miss on that account, when within point blank, or even at a much further distance.

This very circumstance of varying range has been used as an argument in favour of attacking with your broadside in preference to your bow, because it is contended that you can better ascertain and maintain your distance. But I have never seen it explained how this can be possible, nor how you can make an enemy preserve any particular bearing and distance from you. It is to me inconceivable that any enemy armed with a ram will accept a running fight, broadside to broadside, even if his superiority is very considerable.

In the case of attacking a fort, I do not suppose any very great importance will be attached to this alleged inferiority of bow-fire. For myself, I do not believe that it will be found to exist at all, but rather on the contrary, that the rolling motion so general, if not invariable on a sea coast, would more injuriously affect the broadside. I have seen, as I have before stated, excellent and efficient fire from end-on guns, when the broadside ones could not have been cast loose, I believe, or if they could, their fire must have been of the wildest description, with respect to elevation, little removed from haphazard.

But another objection to attacking forts bow-on has been taken on the ground that correct elevation is more difficult to attain than correct direction, and therefore that the deep target presented by the ship's length is more easy to hit than that offered by the broadside, the comparative narrowness being unimportant. But I submit that it is of limited application to forts of moderate height, and at low trajectory ranges; and that when it does apply, the hit must be so obtuse to the deck as to have little effect on that of an ironclad. Moreover from two-thirds to three-fourths of it is amply protected by the box-battery or turrets.

At long ranges it would have more application, but when we consider, on the other hand, the effect of the opposite error of elevation—that is, the shot falling short and ricochetting, I think we have an ample set-off against it. I suppose we may take it for certain that if such a shot rose over the forecastle, it would pass clear over the ship; and that if it did not, it would be absolutely harmless against the sharp end presentation; whereas such a shot hitting the side might produce nearly its full effect, and completely so if it entered a port or struck between wind and water.

Exposed to plunging fire from an elevated fort, the disadvantage of the end-on position would be more considerable. But then I think it

highly probable that the frequent alteration of range that I suggested, to an extent known in the ship, but not to the enemy, would puzzle any land service artillery—who are as a rule unaccustomed to locomotive targets—much more than this circumstance would assist them.

But granting that the hits were more, what would be their effect? I have before dwelt on the difference in vulnerability between the side and the end of a ship; but the ratio of effective value which I allowed of 3 to 1 in favour of the side-hit in the case of ship *versus* ship, must be largely increased in this case, where the position of the ship is almost exactly end-on. I should consider the proportion of 10 to 1 nearer the mark when I reflect that one or two lucky hits on the side might disable a ship, whilst it is difficult to conceive such an effect from the same received on the feather edge.

This estimate must, however, be left to the individual judgment. It leads to another observation made on the discussion of my paper that there is virtue in numbers of guns, and that two will always beat one. Now this can only be accepted on two conditions, by no means to be taken for granted: 1st, that the guns are nearly equal, and, 2nd, that the object is of the same endurance. A fort might suffer much more from one 12-inch shell than from two of 9 inches, and the side of a ship from one 9-inch more than the end would from two of 12 inches. But though the superiority of numbers was advanced in favour of the broadside attack, I claim it entirely for the end-on, for although if the typical ship B in my former paper can continue the fight as long as A, she has the advantage certainly of 6 to 4. Yet I contend and strongly believe that the latter will remain in action twice as long, and thus have the superiority of 8 to 6.

But a ship can carry heavier fore-and-aft guns on or near the line of keel than on the side, or if the same can be fought on the side they will hardly be more numerous.

This question, however, seems almost set at rest by the fact that we appear no longer to build broadside ships. And I am in great hopes that our architects and engineers, who say they can meet all our requirements, if we will only clearly explain them, will before long, either by a further development of the turbine, which seems so perfect in principle and only deficient in speed, or by a different position of the screws, furnish us with a ship capable of moving and ramming astern as well as ahead; for I believe the rudder question presents no insuperable difficulty. I would be the very last to underrate the importance of speed. It is of the first importance to bring your enemy to action, and perhaps of the last importance to secure the fruits of victory; but I venture to think that during the struggle a moderate speed will be the rule, and that a small superiority over your enemy will be sufficient, its value being little, if anything, more than as far as it contributes to turning power. I cannot entertain a doubt that of two rams, artillery apart, the one which turns in the shortest time must win. Now if this one rams both ways, her advantage will evidently be more than doubled, and if we add to this the indisputable superiority of the turbine in turning, and give her also a powerful end-on fire, I think the result would be such as to justify us in accepting

a very considerable diminution of maximum speed. But, with or without the turbine, such an ironclad ram, armed with only one of the heaviest guns that can be carried at sea at each end, and four or five lesser ones on each side, *i.e.*, a total of ten or twelve guns, would be in my opinion much more formidable than anything yet afloat.

By giving the foremost and aftermost side guns a training to ahead and astern respectively, we should have a fore-and-aft fire of three guns, one of which a smasher in combination with the ram and Whitehead, an attack in comparison with which any broadside would be a mere fleabite. Secondary, as I think, to this first consideration, the side armament might consist advantageously of guns no heavier than the 12-ton, because more could be carried, and be fired, I believe, twice if not thrice, as quick as the heavier. Thus four of these would fire from eight to twelve times, and five of them from ten to fifteen times, whilst three of the larger calibre of 25 or 35 tons would fire only three shots, *i.e.*, one each. I am aware that it is contended that one of the heavier projectiles will produce an effect three times as great as one of the other, but I think even this is only on the assumption that it strikes perpendicularly and upon a target that it cannot penetrate.

Now I think it almost certain that in passing a ship backwards and forwards, or at any stage of a *mêlée*, and in the inevitable difficulties caused by smoke and other obstructions, when snap-shots must be the rule, there will be more value in frequent opportunities than on the difference of effect between smaller or larger projectiles, always supposing that the smaller has a fair penetrating or smashing power upon the target of the moment. Should this be impervious to the 12-ton—and it must be an armour exceeding 9 inches thick—then my ram may well be content with her double end-on attack.

In silencing earth batteries, as distinct from destroying forts of solid masonry, the value of a sustained fire from numerous guns will hardly be questioned; nor in case of being opposed to numerous or unarmoured enemies.

Such a ram might have one central telescopic mast of large girth, without rigging, the topmast having shifting stays and backstays, square yards to lower down fore and aft, large topgallant masts and sails for peace time and for making passages—most of this to be landed when considered expedient in war—huge gaffs and fore-and-aft sails. She would carry as much canvas as any ship can in a gale, and almost as much as is useful with a fair wind.

Torpedoes.

Formidable as these weapons of every kind will, no doubt, be found in their proper application, I believe, that in relation to a fight at sea, we may safely confine our consideration to the Whitehead. To attempt to use the Harvey by any ship having heavy guns, or a ram, would be a waste of power worse than futile, and fraught with more danger to the ship using it, or to her friend astern, than to the enemy. It may have its opportunity, and I can well believe might be used with good effect by small vessels against ships at anchor, if torpedo

boats are not available, but so far as concerns fights at sea, I would make a present to the enemy of every one in Her Majesty's arsenals. Not so with the explosive Fish, of which, however, I have no experience and therefore little to say. But I feel strongly that if they can only effect upon a live locomotive enemy a small fraction of what they profess, and indeed have done upon an inanimate dummy, and if they can be projected ahead say from 500 to 600 yards, from a ship going at a speed of 5 or 6 knots, which I do not doubt, then they supply at once the most formidable addition to the strength of the end-on attack, and to the weakness of the broadside presentation.

The value of the fixed torpedo, or submarine mine, for defensive purposes is beyond all question, and perhaps can hardly be overrated; but it does not come within the scope of my subject. The study and practice of it, however, together with the no less interesting counter-operation of removing or destroying them, has involved the necessity of a knowledge of electricity, which has led to its application to firing the guns on board ship, which is a very important accessory to the naval engagement. I therefore venture the following observations.

On Electric Firing.

I must premise that I am an inexpert, but I think it may be useful to represent this subject from the point of view of one of that, as yet I believe, large majority. I by no means represent that majority, and the views I shall put forward (which are simply my own), may be singular in more than one sense, as they go so far as to defend the seeming paradox that those who know most about it, or experts, are not at all necessarily the most trustworthy guides. An accomplished musician, who can rattle off at pleasure any air you like from "Black "Eyed Susan" to Mozart's Last Requiem without a fault, need not be the best judge of the capacity of others for music, or of its power to soothe the savage breast or inspire martial ardour. Is there not a little danger that, enamoured of his art, he may be prone to over-estimate its power and field of application, or on the other hand, to underrate the difficulties of its general diffusion; and may not electricians be unconsciously exposed to something of the same inexact balance of judgment upon theirs? If you hinted to the harpist at the possibility of his instrument being out of tune, or having a string broken, he would instantly produce from his pocket his tuning key and spare string, and assure you truthfully that it should be all right in a minute. The electrician would say that his instrument as applied to firing guns is equally simple, and equally easily put to rights. There may be some difference in degree as to the inconvenience and disappointment caused by the short interruption, but we will let that pass. The electrician might further observe, that his instrument is less liable to the casualty, and would be better compared to a piano, which is hardly ever liable to a broken string; but he would have forgotten that pianos are neither intended for, nor are used as targets, which ships are, nor can he reply that his apparatus is under armour protection, for it is

applied to the unarmoured. But it may be said that the experience of a considerable length of time has proved that it is sufficiently reliable and safe, and if not positively free from danger of miscarriage, so neither is any other system.

First then, I would enquire into the character of this experience. Has it been gained in war of any kind? Has it been successfully used against a fire in return? Has it been acquired in ships at sea, in all climates, or confined to training ships and some others, commanded by Officers of exceptional attainments in this specialité?

Next, I would ask of the fleet generally if their batteries have always been found in perfect condition, the wires in place, free from injury or obstruction, and everything in working order at the shortest notice; mind, I do not mean at a certain weekly hour, anticipated with as much regularity as the drop of the ball at Greenwich Observatory, nor on the occasion of Admiral's inspections, but at all other times. If this be their experience, and if they have always, or nearly always (for generally is not sufficient), found the guns go off as desired, then I can only say I shall be very glad to hear it, and I think I shall have done good service in eliciting the fact, because I believe there are a large number of younger Officers who are tainted with my own sin of scepticism or infidelity, and such assurance might go far to convert them to the true faith, a matter of very great consequence.

But now that we have been completely reassured as to its reliability, I come to the question, what is the advantage it claims?

I understand it thus: That some skilful person, in a position removed from the various disturbing influences of the gun-battery, and with an unobstructed range of view, so that he can better foresee and prepare for the enemy coming under fire, can best direct and most instantaneously deliver that fire; and further that, if it be desired to concentrate any number of guns, the important advantage of absolute simultaneity of discharge is secured.

I believe this to be a fair statement of its claims. Let us consider it.

Granting, for a moment, that such a position can be found, I submit that, if the director's range of vision be comparatively unobstructed, his vision itself is limited. He can only look, or point his instrument, in one direction at a time. If there be but one enemy, and he can see him, so far good. But what if there are more? If the answer be that, as a rule, a ship engages only one at a time, grant this, too, though it is a great concession; but which shall be the one, if more are present? Again, let there be only one; but, just as the director is about to get him on, the smoke from the enemy, or a friend at hand, or even a gun from his own ship, if there be one free from the paralysis of the system, or any other obstruction, interferes with his view, the chance is lost; when, perhaps, every gun in the ship, or at least those to windward of the said smoke, might have seen clearly.

But is there such a position as is assumed for our director? There are usually, I believe, two firing places fitted on each side of a ship,

and, no doubt, there may be many more; but which is to be the one selected? That which promised to be the best may not so turn out; or, if it does at one period of the action, it will not be so at another; and can there be a frequent change?

Is there not also a serious disadvantage arising from his not being able to see anything, or speak to anybody, in the battery? so that, if a gun be primed, he may fire it, whether pointed or not; or, on the other hand, miss the opportunity by waiting for the information. Is it not also a complete surrender of control over the firing to an individual most exposed of anybody on the ship, involving a complete collapse for a time, if he should be wounded, and whose claim to an unobstructed view can by no means be admitted. If unrestricted by the narrow limits of a port, it is exposed to obstructions of its own, especially that of coal smoke, which has caused most of us frequently to pocket our pride, and to wear an article not included in Her Majesty's Regulations, commonly known as goggles, and not calculated to improve our vision. The smoke from the guns, also, often obstructs our view more from the upper deck than from the main. There are also obstructions of funnels, masts, perhaps turrets—and even the very circumstance of his view being so widened, embracing, perhaps, many surrounding objects—is calculated to distract the mind and eyesight.

But now let me make an illustration of an engagement.

The enemy heaves in sight. A cheer, which the strictest disciplinarian cannot object to, roars through the ship. The drum beats to quarters, and the Captain assembles the Officers commanding the different divisions of guns for his orders.

He commences by informing them that now is their time. They evince not the slightest objection; and he adds that "England expects "every man to do his duty." Well, they are a little startled by this novelty, and the unheard-of unreasonableness of Great Britain, but they preserve their *sang froid*, and he proceeds to give instructions as to the range he intends to begin at—flattering himself, perhaps, that the enemy is going to let him have this all his own way—then the projectiles and charges to be used—if there be a choice—and finally he comes to the matter of electric firing. Now, I submit that we have arrived at a time when figure of speech and all levity must cease. Theory must fall out and drop to the rear, and Practice alone come to the front; and I wish to put this practical question to practical men—What are these orders to be? Shall they be:—

1. Fire by electricity the first round or broadside, and afterwards by hand; or
2. Fire by electricity until further orders; or
3. One division by electricity, the rest by hand; or
4. Any other orders you please to substitute?

Now, I contend that the Captain is compromised. I do not say that any changes or further orders are impossible; but I do say that, whoever leans much upon their utility, leans upon a reed.

I have not been very often under fire; but I received my *baptême de feu* more than forty years ago, and subsequent immersions have

shown me that, when the fight is begun, fresh orders are very difficult to disseminate, either by voice, message, or voice-tube; very liable to misconstruction, mis-delivery, or non-delivery, and to disobedience, of course not wilful. Experience has also taught me not to expect exactly the same steadiness or attention to minute details under fire as at target practice. That even in competitive firing in cool blood, haste and excitement not unusually cause mistakes, and that to require changes backward and forward, from one system to another, is to produce confusion and to court disaster.

But it may be said, and, indeed, I think the believers in this firing are bound to say, that this is all a myth, as they contemplate no change, but intend to stick to their style.

Very well, then, the next question I ask is, can they open fire as quick as by hand firing? Here I feel I am exposing myself to some ridicule, for insinuating that there can be any process to be compared in rapidity with lightning and electricity. Still it would be reassuring to have the authority of experience for the fact. Next, is there any possibility of guns missing fire? Answer—Yes; but not more than in hand firing. Good; but in the latter case a new tube is put in at once, the gun relaid and fired, when it bears. How is this done—by electricity? Answer—Exactly in the same manner. But is this so? How does the captain of the gun know that it has missed? Answer—By its not going off. But how does he know that the attempt has been made? If he guesses it from others having fired, what is he to do? Prime again. Then how does the firer know the gun has missed, and when it is ready again? The captain of the gun cannot prime with a friction tube, and fire by hand, because that is not sticking to the system; besides, he does not know what to fire at, or where to look for his object. His only orders have necessarily been to lay his gun horizontal, or at a given elevation and degree of training, not to fire at all, and be very careful to prime with the right tube, *i.e.*, one which he cannot possibly fire.

I will not suggest the possibility of a mistake on this last point, either now or at any future stage of the action, but some people might think it not quite impossible.

But when this cobweb of imaginary difficulties has been brushed away, we come to another practical question.

Who is to direct the various changes either of object, or manning the guns, which the progress of the action will require? Answer—The Captain. But, will any one pretend that, whilst handling his huge ship amongst a number of friends and foes in the tumult and smoke of battle, he will be able to attend to details of the gunnery? He can only give general orders; and are the more detailed ones to be left to the director of firing, or the Commander, or to each Lieutenant for his own quarters? If so, how is unity of design and concurrence of action between these various Officers respecting the electric fire to be attained? Again, is the system applicable to night action? If so, I must ask whether experience has proven that, in a battery, where men mess and sleep, the hammocks or mess-gear never interfere with the wires, and whether, in this case, the first round will be fired as

quickly as by hand, and, if not, how much longer would be allowed to be the average time? If it is not meant for night action, then we have one system for night and another or a double one for day; which, then, is to be adopted at that perhaps most important time of all, which is neither the one nor the other, viz., the early dawn?

Once more, when showery or hazy weather, or other causes permit only intermittent views, now from one part, and now from another of the ship, which is to be the system?

Now, if the answer to these questions be that, of course, it is only meant for special and suitable occasions, and when there is plenty of time for preparation, which, after all, is almost invariably the case, I can only say, you are not in the habit of admitting the last plea, with reference to any other preparation for battle, though I doubt if there be any requiring so much time; and as to the probable frequency of the suitable occasions, well, I may have my own private opinion, but that is no good to anybody. Let us pass from what must, at best, be very speculative, to what is, perhaps, the most important practical question which can be put to any advocate of the broadside attack, but especially to the believer in its electric delivery, viz.:—

What is the utmost effect to be reasonably expected from the most perfect success of such a broadside, and delivered at the most favourable target which your enemy can present, viz., his broadside? Terrific? granted! Conclusive? certainly not granted! nor to be named in the same day with that of the ram. But, whatever the effect, what right have you to expect that you will not receive the same in return? Well, you may say that would be only fair play, a fair give and take. But I don't like fair play of that sort. I want to give all and take nothing. Now, if the utmost success you dare to expect is to result in nothing more than quits, is it not worth while to reconsider the cost, or, in other words, the risk and consequences of any possible failure?

Is there really no risk of some hitch in the electric apparatus? No risk of tubes missing fire? No possibility of your director failing to make a bull's eye, or of his sight being interfered with by coal smoke or other obstruction? Is there none of the guns being inaccurately trained, or, if they have been laid exactly abeam, of the enemy opening fire first and thus baulking his aim. Above all, is there any certainty that the enemy will be willing so mildly to present his cheek to your salute, instead of prefering to receive it end-on or aslant?

Now, if any one of these, or other not improbable occurrences (a speck of soot might be sufficient) neutralizes your broadside, what is your position? You have thrown away the most precious opportunity perhaps of the whole day, exposed yourself to the most injurious fire, if your adversary has presented his broadside, or to the greatest risk of his ram if otherwise, and in either case to his torpedoes, and if you have escaped all these, you have now really to begin the battle on your own behalf under great disadvantage and on a different system.

But it may be said, it is true the consequences of failure would be

serious, but so would they be under the common system. The result of failure would be the same, whilst that of success could not be equal to that of ours. Is this so?

In the first place, the hand firing is obviously not open to some of the mishaps at all, and the importance of those to which it is liable, has to be divided by the number of guns in the ship. But it is not on these grounds only that I object to it so much, I disapprove also of the erroneous and inefficient principle upon which the whole artillery-power of the ship is developed.

I have sketched the Captain's orders on beating to quarters under the electric system, let us compare those which might be suitable to the other.

They would materially differ after the first preliminary ones. I might not myself adhere to the letter of that which I will suggest, but I think the spirit will bear examination and not be found very wide of the mark. It recommends itself as a single one, simple and unmistakable, and if somewhat too celestial in style, I adopt it because I hope to score a point presently from the very wording. It would be thus: "Gentlemen, you have just learnt from me England's "expectations. Let them be fulfilled! I have spoken."

Thereupon the Officers reply in the true old-fashioned dialect, "Ay, ay, sir," and rush to their quarters, muttering that if their promotion is half as safe as England's expectations, it will be all right, and they proceed to instruct the captains of their guns. How? Why following the example of their chief in one simple unmistakable order. Thus: "Never fire a shot until you are sure of your aim, "and never fail to do so when you are."

Now I beg to contrast this order with those which were inevitable under the former system, viz., "lay your guns at a certain elevation "and direction; don't fire at all, and be careful to use a tube which "will make it impossible."

I ask each gentleman to take his choice. *Chacun à son goût.*

Now, I said I hoped to score a point from the very words of the Captain's orders.

Under those of the first system, what were the duties of the Officers addressed? Simple enough. They were merely to see that their guns were laid in the fixed position ordered, but I don't know by whom (probably the Captain in the first instance, but afterwards I cannot tell), and then be stagnant. This process might have to be repeated, but I should certainly think Britannia very unreasonable if she expected anything more than that they should see this duty performed with the utmost exactness and celerity.

Under the second system each Officer has the fullest scope for all his energies; judgment of distance, and every other gunnery ability he may have, and every captain of a gun for his well-trained, practised eyesight. No doubt the director of firing may be assumed to be the best artillerist in the ship, taken all round; but I have no reason to believe that he can generally be depended upon to return on board with the heaviest game-bag. In respect of aim, any captain of a gun may be quite his equal. But to return to the Lieutenant commanding

a division of guns. Instead of being confined, tied down to a rigid mechanical process, paralyzed until released at some uncertain period of the engagement, when he would begin to use his faculties under the enormous disadvantage of the noise and smoke of battle, already at its height; instead of this, he would, from the very first, throw his whole soul into the work, stimulating his men by turns to the utmost exertion and smartness, and to the most deliberate coolness and steadiness; he would feel an interest in the fight not one whit inferior to that of the Captain, and even a responsibility only less in proportion to his position. He dispatches two Midshipmen to look out in different directions, and give him notice of an approaching foe. They both return in excitement at the same moment to report one coming up from each direction. The Lieutenant coolly replies "All right! "No. 1 gun, look out, muzzle left; No. 3 gun, look out, muzzle right;" whilst an A.D.C. from the Captain arrives to say that one of them has struck; just at the moment when the electric firer, from his isolated position, either ignorant of the fact, would fire into her; or, thinking the message applied to the ship he was covering, instead of the other, would withhold the fire he should deliver.

Again, my Lieutenant, instead of being embarrassed by change of system, bound to come sooner or later under the first method, and by manifold and perhaps conflicting orders from time to time from different authorities, would receive every assistance from the Captain and others in information of any error in his range, or on other points, warning of approaching opportunities, and presently that the ship is going to turn round or alter course, bringing the enemy on the opposite side. He simply mans his opposite guns, and is as ready as ever. I do not know how, under the other system, co-operation in such cases can be attained between the different divisional Officers of guns and the director of firing; and surely this is only one of the manifold changes which must be perpetually recurring in a naval action.

Now, if I have expressed opinions somewhat adverse to electric firing in engagements of ships, I would not be supposed to dispute its probable great value under other circumstances. As for example, in forts commanding narrow channels of approach to harbours, &c., or even perhaps, occasionally on board ships engaging forts or fixed objects; but I cannot divest my mind of some apprehension, when I reflect that we are training up a whole school, if not a generation of Officers, in the study and practice of electricity, who must inevitably be struck by the interest, the beauty, the power of the science, its extensive, almost unlimited field of application, and be charmed by the marvellous results attained with such ease and certainty under the conditions in which they witness their repented experiments. When we see launches sent away without a living soul in them, laying down a whole series of torpedoes, and returning to the ship, as if to report that they have completed the obstruction of a big-ship channel, apparently without mortal aid; when I say they are habituated to such results, and all sorts of more commonplace operations successfully performed, though under the most favourable conditions; are they not in some danger of over-confidence in similar success, and of taking

too light a view of the chances, and especially of the serious result of failure under the very different conditions of actual war?

As an example of enthusiasm in this art, let me mention with the greatest respect for a gentleman so eminent in practical science as Mr. Bessemer, his very ingenious and beautiful application of electricity to firing ships' guns automatically, by which the gun is fired, exactly when the roll of the ship gives its axis a certain predetermined elevation above the horizon. It assumes, however (I do not know on what grounds), that the ship must have that amount of roll, also that the roll will be synchronous with the desired opportunity of firing. It requires the elevation to be predetermined, but it is not explained how, or by whom nor how a ship can certainly pass another at any exact distance, especially if that other is not a consenting party, and it leaves the still more difficult problem untouched, viz., if you do succeed in getting him on the spot you wish, how to keep him and yourself in those exact relative positions. Now I hope Mr. Bessemer will excuse me if I venture to suggest that theory here has not been sufficiently checked by practical considerations.

I do not think that naval Officers can accept this invention, nor would I insinuate that they are in danger of allowing theory to run away with them so far. But it may serve as a caution, lest they should in some degree permit partiality and love of their art, unduly to warp their dispassionate judgment.

In putting forward the foregoing views, I am conscious of great presumption, because they must be opposed to those of real authority on the subject, but I have given my reasons for doing so, and I venture to think the automatic invention some justification of those reasons; but I am not vain enough to suppose that my views can be entirely right, nor am I humble enough to think they can be entirely wrong. I am hopeful that they may be thought worthy of some consideration and reflection, and sanguine that such reflection may contribute to throwing a clearer, a more electric light upon the subject.

The CHAIRMAN: As you are aware, gentlemen, this is a continuation of the question which was so ably raised at one of our recent meetings. You have, no doubt, noticed the different points which have been touched upon to-day. First of all, Admiral Randolph has sketched out the armaments of the ship which he has in his mind as the best ship for the future. He did *not* do that in his former lecture. He has dwelt at considerable length on the superior advantages, as he contends, of end-on fire; and, lastly, he has spoken of the disadvantage of relying so much as he thinks we are inclined to do, on electric firing. These are the three principal points which he has brought forward, and to which gentlemen should address their remarks.

Commander CURTIS: I think there is a good deal in the remarks of Admiral Randolph with regard to electric firing. The "Thunderer" explosion report confirms what Admiral Randolph says, that the Captain knows little or nothing about what the gun is really doing.[1] Some time ago I advocated that the ram should be a double-ender, having two rudders and two screws at each end, so that it can be fixed in with the dead wood. I think it possible for a ram to be able to deliver a blow of 2,000 or 3,000 tons, or sufficient force to stave a ship, by hydraulic piston, or combined hydraulic and spring piston, thus preventing the shock of the blow being

[1] Two miss-fires out of four guns.

transmitted throughout the whole ship. It is generally admitted that if a ship strikes another, the whole blow, with the exception of a certain force which staves the other, is transmitted through every bolt in the ship, and I think that the ram should have some elasticity[1] in the part that strikes another ship. With respect to end-on fire I think that the heavy guns will do the most destruction, and the ship itself will receive least damage, inasmuch as the shot would glance off from the armoured ends or bows, and not only that, but you are in a position to ram after delivering the fire. With respect to the Whitehead torpedo, if in going into the water it does not strike the surface diametrically in the straight line of the ship, it goes down to the left or the right and appears to be very erratic in its motion from ships going any speed. I am not well acquainted with electric firing, but I imagine that if the guns converge on one point, to fire a broadside by electricity will be a good thing. The Gunnery Lieutenant should control the guns, receiving general instructions from the Captain. I doubt whether the Captain could conduct his ship and fire by electricity at the same time. He has too much to do; at least, I should be sorry to have to do it. I think with bold Officers and torpedo boats a great deal may be done. If I had command of a ship I should tell one of the Lieutenants or Midshipmen to take charge of one of the torpedo boats, and do the best he could to destroy the enemy. I saw in "Blackwood" the other day that the small boats are not likely to be of much use, inasmuch as there would be too much sea on or heavy swell for them to work. Naval men know when boats can work, and what seas they can survive in. It is almost impossible for one of the large ships to hit a launch going 12 or 15 knots at sea, and naturally you would not choose a gale of wind for an action. I agree with Admiral Randolph, that at present we are not so scientific that we can fire at sea by electricity with confidence to Officers and men.

I think the spar torpedo can be more fully developed, our gunboats and merchant defence cruizers being fitted with them—not only end-on but otherwise; and if every ship of war should have a ram as an adjunct to the ship ends, it need not, I respectfully submit, be built up to make it a rigid mass, and of great weight.

I submit that the tactics are now just reversed by firing end-on, you expose your ship the least, your propelling power is less likely to be destroyed; in fact you show the feather edge, and hit out with your heaviest guns on your enemies weakest parts, and you can torpedo and ram in succession.

Admiral Sir SPENCER ROBINSON: I have not had the advantage of reading Admiral Randolph's first lecture, and can only, therefore, venture to make a few remarks on what I have heard to-day. I think his paper is extremely interesting, and I concur in most of the principles he has laid down, so far as I have been able to follow them, especially with regard to the general scope of the paper—the advantages of end-on in comparison with broadside fire from ironclad ships. I cannot but conceive that there is very considerable advantage in the position of a ship which is to receive the fire of heavy guns end-on. So far I go entirely with Admiral Randolph. Much less mischief would probably be done by the progress of the shot when it enters the bows and leaves the stern than would be done by a shot which passes through the broadside of a ship. Admiral Randolph is right in saying that a ship end-on presents the longer target, and that a shot is more likely to hit a length of 450 feet if the elevation is exactly right than it is to hit a target equal to the beam of a ship, 50 or 60 feet. There is that consideration, but I do not know that it is not completely balanced by the advantage of receiving shot end-on rather than through the broadside. The difficulties attending the elevation of the gun, when you are approaching with end-on fire, are very considerable, no doubt. I believe that, under the circumstances, one shot in ten would miss the ship altogether. What Admiral Randolph observed, and what I think is true, is this, that you have nearly the same difficulty when you are passing a ship obliquely or broadside to broadside. The distance varies so rapidly that what is right one second is wrong in another second. The elevation to ensure your striking the object at one moment will be too much and the next moment too little; and the

[1] Since I have heard Professor Siemens' lecture on the elasticity of steel, I feel pretty confident our naval architects, if directed, could place an elastic ram on either end of our ships, of pointed arch form, or otherwise.

difficulty of knowing the exact moment to fire your gun, when you are passing a ship obliquely, is so great as to equal the difficulty of finding the exact elevation when approaching end-on. I think there is very little allowance to be made for one case over the other. In either case, the most experienced artillerist will not fail to miss a great many times. That leads me to remark upon a subject which Admiral Randolph has discussed, and I think very justly. I prefer a small number of guns to one large one, because, although the effect of a very large gun is something so great that our minds can hardly grasp it, yet a small number of guns may often secure your planting two or three decided hits when you will not succeed in getting a smashing blow from a great gun. I cannot help thinking—indeed, the principle is one in which everybody who has had experience will agree—that it is not possible to make so sure of a projectile doing its work when you can get that projectile off once in three or four minutes, as when you have four or five which you can get off in every two or three minutes. Your projectile must be an effective one. It is no use throwing an egg against a brick wall. The projectile must be capable of penetrating and doing the mischief that penetration must cause, and therefore it must be of a certain size, because you are certain you will meet armour plates of great thickness, and more and more so every day. I have heard mention of a gun for which I have the greatest possible respect, and which I think could be used effectually against ironclads of the present day—that is the 38-ton, 12·4-inch calibre. That is a most powerful weapon, and it has been supplied to the foremost turret of the "Thunderer." I do not consider that that projectile is too large to be effectively used in a ship at sea, and I believe it will be the master of almost every ironclad that foreign Powers are likely to send to sea, or that we ourselves can send to sea, in all weathers and in all places. When we come to the monster projectile weighing 1,700 lbs., fired with a charge of 370 lbs. of powder, such as the "Inflexible" fires, we must consider what a long time must elapse, if your shot should miss, before you can fire another at the enemy. I would rather go to sea with four 38-ton guns than with one of the "Inflexible" class. A shot from the "Inflexible" gun, with a projectile of 1,700 lbs. and a charge of 370 lbs. of powder, will have a total energy on impact of 29,607 tons. Of course, such a blow as that will be most smashing and effectual. But, then, you must hit, and the chances that you will not hit are not diminished the least in the world by the size of the projectile. The time that you will lose in loading the gun again, in getting the right elevation, and all that, will very much diminish the chance of bringing the action to a satisfactory close. As to Admiral Randolph's remarks about electricity, I hardly agree with them. I do not think he has given that part of the subject as much consideration as he has the other. I think we shall find that practice will show that a great deal more may be done than he supposes by the discharge of guns by electricity. The example which he has brought before us as condemnatory of the idea is, to my mind, illustrative, and not only illustrative, but commendatory of the idea. There was a letter in the *Times*, the other day, from Mr. Henry Bessemer. When I was at the Admiralty, I attended one of the evening lectures, when Mr. Bessemer brought his apparatus here, and showed very reasonable grounds for believing that he could, with the greatest accuracy, fire a gun automatically at the moment that the sight was on. Now, a ship rolling even moderately 8 or 10 degrees each way, with 12 or 13 seconds between each roll, will give some idea of the short time she will be on the top of the wave when you can see the object to be aimed at. I cannot now go further than say that the thing did impress me very much as being practicable. This is just like the case of a great many other scientific apparatus. When they first come before untrained men, they are apt to be received with disfavour and dissatisfaction. I remember how the rifling of great guns was originally received. I know how the application of steam to ships at sea was received. Many difficulties were put forward with great show of reason, and, as a matter of fact, the objections were perfectly true, but then they are obviated, and the whole of our lives, and of everything we do, seem to me to be a compromise between advantages and disadvantages. I think, therefore, that we may do more with electricity than Admiral Randolph seems disposed to think, and the application of Mr. Bessemer's system of automatically firing a single gun with the certainty that, at the moment of its discharge, the sight is on, will be a great improvement in the practice of gunnery.

Commander CUSTANCE: I have read Admiral Randolph's previous lecture with a great deal of interest, and I presume I shall not be out of order in discussing that in connection with the present paper. In the first place, I will refer to the remarks of Admiral Randolph in reference to tactics in former days. From his appeal to Nelson's shades, I gather that he does not allow that Officer to have been a tactician. I, on the contrary, think he must have been a tactician of the highest order. Surely it cannot be said that the victory of the Nile was gained by accident. No, the masterly tactic of doubling on the enemies' weather ships was the fruit of long study and accurate knowledge of the subject. Again, at St. Vincent, when Sir John Jervis made signals for ships to take stations for mutual support, and ten minutes after, Nelson wore his ship to prevent the Spanish weather division from joining the ships to leeward, was not that tactical skill of the highest order? If Admiral Randolph should be in command of a squadron in a future war, I could wish him nothing better than to have a subordinate who would so readily respond to his orders. As to Trafalgar, I think those who heard Professor Laughton's explanation of that battle will admit that there was not a want of tactics on the side of the English. I think we owe a debt of gratitude to Professor Laughton for investigating the subject as he has done. The question we are now considering, however, is that of the "relative importance" of end-on and broadside fire. That word "relative" is the point of the whole matter. No one doubts that end-on fire is a good thing. Of course it is, if you can make it effective. I contend that the way in which Admiral Randolph has handled this subject will not lead to a determination of the relative importance of the two. His conclusions are no doubt right; but his arguments, as they appear to me to be from false premisses, must be wrong. Admiral Randolph admits they are all wrong, and therefore the arguments must be wrong. Now, the question is, what is the proper way of working out this question? I think it must be worked out piecemeal. We have none of us sufficient accurately data to determine it; we have not gone into the subject deeply enough, nor with sufficient accuracy. There are a dozen questions involved here, and each one of them must be worked out independently. In the first instance, you must, I consider, thoroughly investigate the question for single ships before you can proceed to squadrons. The most simple case must come first. In considering the relative importance of end-on and broadside fire, the first question is, what opportunities will you get for firing? Now, what does the opportunity depend on? It depends on the time one ship is exposed to the fire of the other, whether your guns will bear, and whether you are within striking distance. That may be worked out mathematically. The results for the "Thunderer" might have been used, her course having been plotted out with the greatest accuracy, and the same thing might be done for other ships. At present we have only the course plotted for the "Thunderer." Having that plotted, it is easy to determine the relative bearing of the "Thunderer" from instant to instant; and I would propose that the results should be represented by a curve—abscissæ representing time, and the ordinate the corresponding bearings. The bearing is a continuous function of the time, and thus gives a continuous curve which would show at a glance when it is possible to fire. There would be great advantage in this, because for any series of manœuvres you would be able to see at a glance when your guns would bear—for what time—by merely looking at the diagram. In the same way for distance. This would simplify the theoretical consideration of the question. That part of the question for the assumed conditions would be settled absolutely accurately. That is the great point. Then we can go on to the next point, being certain that we are accurate as far as we have gone. The next point is, how many shots can you fire in the time? That is a practical question which can only be settled practically. Admiral Randolph says a round a minute. I should like to ask what practical data is that founded on, for data which are obtained from prize firing are not reliable. The number of good shots which can be fired does not depend on the number of guns. There is a certain limit. If you increase the number of guns, you increase the number of good shots which can be fired up to a certain limit, and when you get beyond that, the number of good shots which can be fired, decreases. That limit is a comparatively low one, but it can only be determined by experiment—it would not require very large and extensive experiments. Very few would be able to determine what

was the number of guns from which you could get the maximum number of good shots under certain conditions. Having determined the time allowed for firing, and the number of good shots which can be fired in that time, the next question is how many of them will hit? That is a mathematical question which has been worked out mathematically by a Russian Officer, and the results of which will, I believe, thanks to Lieutenant Lees, be published in the Journal of this Institution. That will clear the way to a great extent in this matter, because it works the question out accurately. It assumes certain conditions, and we can then compare under these conditions the end-on fire with the broadside fire. This theoretical knowledge of the possibilities is of great importance, because it teaches us what is possible and what is not possible. In the course of conversation, a friend said to me "I like end-on fire." I asked "At what distance would you open fire?" Reply, "Two miles." I asked "What would be the chance of hitting at that distance? Would you be surprised to "hear it was 200 per cent. against you?" This is an example of the very hazy notions in that respect, because the question has not been gone into accurately. I maintain that as far as theory goes it can be done accurately—generalities will not settle the question. To pass on rapidly to a consideration of the question. In what way does theory say we can improve? This is the most instructive lesson to learn from looking at the question from this theoretical point of view, and it is a theoretical one we are looking at it from. Having determined the theoretical possibilities, we can afterwards determine whether they are practically possible. First determine the theoretical possibilities and impossibilities, then apply experiment to ascertain whether they are practically possible. In what direction can you improve? Well, you may improve immensely by having things SIMPLER—that has been alluded to by former speakers as regards altering your firing in an action; but there is another point, viz., the different sorts of charges and projectiles which causes immense complication. It is none of it practical. If you have only one charge, that will simplify your carriages, your service of ammunition, &c.

As to the electric firing, I think Admiral Randolph's attack would have been much heavier if he had quite understood the question. But I do not think that he quite understood it from what I can gather—he will pardon me for saying so, but I think the attack against it might be made much heavier. It wants working out, it wants going into as Sir Spencer Robinson suggested; it is a great deal in the rough. We are getting better, but it is still very much in the rough. You must remember that one reason why the electric firing was introduced was, that having a number of guns on the broadside, it was difficult to control them; and it was supposed that by introducing electricity, they would be more under command, and there would be less danger of firing into your friends, a thing very likely to be done through smoke and small ports. This matter of electric fire can also be handled mathematically and accurately. Of course, I know I shall be laughed at for looking at it in this way, but there is a theoretical side to the question, and I now look at it from its theoretical side. I will not argue from points which are not proved. I think if the question is worked out, it will be possible to determine the relative chances of hitting with the electric firing with those of hitting while firing independently.[1] I think with the present arrangements, the chances against hitting whilst firing electrically, are rather large. Perhaps the most glaring case of this matter being overdone, will be found in its application to turret ships, where the guns are already concentrated in the hands of two men, and yet they are taken out of their hands and put it into those of a man in the conning tower. This limits the possibility of firing. The enemy cannot be followed round. It is necessary to move your ship; it is impossible to alter the position of your guns. In that case I think the principle has been pushed to an extreme. But the point to which I particularly

[1] I do not mean to argue that this matter can be decided upon purely theoretical grounds, because I know it cannot. I urge well considered experiments, and that all the theoretical investigations, before and after these experiments, shall be carried on with mathematical precision. In fact, I want to see the same method applied to this question, as Mr. W. Froude has so successively made use of for the rolling of ships.—R. N. C.

wish to draw attention is "the question of mounting." The theoretical consideration of this matter leads one up to the causes of the great inaccuracy of firing. These are, as Admiral Randolph has said, changes in distances and bearing, and heel of the ship due to the helm. It is necessary to be able to keep the gun on the move. We want to be able to move it freely in the horizontal and vertical direction up to the instant of firing. Those who have seen the manufacture of iron by the Bessemer process, have seen what I mean—the immense cauldrons turned round and tilted up at the same time. That is what is required, and it is easy. It can be done, and it has been done. It was applied in the gunboats built for the Chinese Government; it is going to be applied in the "Inflexible;" but these applications are with hydraulic machinery. Now I want it applied to guns worked by manual power; and I have no doubt there are dozens of men in England who would do it if you only told them. It would be of the greatest advantage, as you will see, to be able to follow your enemy about readily. This quickness of laying will be to naval warfare what the introduction of the breech-loader was to land warfare. Before concluding, I wish to give credit where it is due. This last idea I owe to the present commander of the "Temeraire," Albert Baldwin Jenkins, whose practical eye was readily alive to the disadvantages of the present system.

Captain LONG: With regard to the relative importance of different firings, it appears to me the question has turned so much on the accurate firing of artillery, that I should like to say one or two words bearing on what Captain Custance has said. There is no statement in the gunnery book, so far as I am aware, which enables you to judge of the permissible error in the estimation of distances in firing a gun. Now, there is a very simple statement about that in a lecture published by an artillery officer, Major J. Sladen,[1] and it strikes me as being far more practical than anything I have seen. One of the statements is, that four times the square of the time of flight in seconds gives you the maximum height of the trajectory in feet; and the other is, that the angle of descent may be taken as being one-third more than the angle of elevation. That is a very useful thing to know. There is one part of the difficulty of firing guns which has not been noticed, and that is the angular velocity of the ship in turning. It is the opinion of most people that ships in action are going to be turning the whole time. Now, the maximum angular velocity of the "Thunderer" in turning is 1° 22′ a second. The gun will have to be moved remarkably quickly to keep up to that. I think this bears very much on the question of electric *versus* eye firing, as to whether it will be possible in these days to get orders passed down quick enough, combining the variation of distance and angular velocity. My experience of carrying on target practice in a small sloop at sea, which I commanded, is that it would be utterly impossible to do anything more than lay your gun at a pre-determined distance, say 500 yards, as preserving pretty nearly the whole of its piercing power, and to fire whenever it would bear, but whether electrically or otherwise, I have not sufficient experience to give an opinion. I should like to ask, as I did on the last occasion, when there was not time to answer, whether Admiral Randolph has considered the relative superiority of bow fire, with regard to attacking groups instead of vessels in line.

Captain COLOMB: It has been ruled, Sir, by you, that I shall not be out of order in referring to the former lecture; and after one or two remarks on what the Admiral has said to-day, I propose to go back for a short time to Diagram No. 1 in that paper. I want, if I may, to define my position as to this question of end-on and broadside fire. Our gallant Chairman, at the last meeting, rather said that if I had the opportunity I would discard bow fire altogether. I look at the question from two points of view. I am not satisfied; and since I have had the opportunity of going over Admiral Randolph's diagrams again, I am less satisfied than I was before of the relative value of end-on fire. But that is one question. What one would do if one had the power is a totally different question: and I take it that the persons in power—those who are in charge of the building of our ships, and the arming of them, are bound to go by the general opinion of the Navy, whatever their

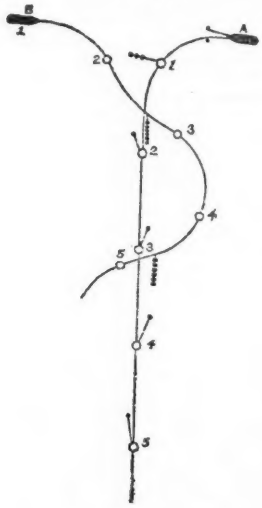
[1] Major J. Sladen, R.A., Professor of Artillery at the R.M. Academy, Woolwich, has published a valuable book, "Principles of Gunnery Rifled Ordnance."

own private opinions may be; and, if that were my case, I certainly should go in opposition to my own opinions in view of the general opinion of the Navy; but I should exert all the powers I possess to have the question decided for certain either one way or the other. The Admiral dwelt at first in his lecture on the inaccuracy of bow guns *per se*. Of course, that is a point in the controversy: but it is not a point on which I have ever laid very much stress. I know, as a fact—we all know, as a fact—that, from one cause or another, the fire of bow guns is always more inaccurate than the fire of broadside guns. In cases where I have examined it, I have found the lost shot were 26 per cent. for the bow, and only 16 per cent. for the broadside gun, at very much the same distance. In speaking of the value of shot, the Admiral reverted to that also, and I rather agree with Captain Custance that it is a subject which requires a very careful working out before one can get at it. In the first place, there is no question whatever but that you must look at the value of your shot for range in this way--that the chances of its hitting must diminish, at least as the square of the distance. It is very much more than that; but we must start with that as an absolute certainty. There are then two questions before us in speaking of broadside *versus* end-on fire. One must not omit to notice that mounting guns on the broadside is one thing, and firing guns in broadside is another thing. A man might wish to mount his guns on the broadside, and yet utterly abhor firing by broadsides. It is important we should note that there is this difference, because otherwise we are liable to imagine that any person who condemns end-on fire, as related to broadside, must fire his guns, in broadsides possibly, by electricity, but this does not follow. I would give you my experience on the question of electric firing. I have fired a good many broadsides from two batteries—five guns in battery, three in the lower and two in the upper. I fired them in a great many ways, both by electricity and by word of mouth; and I am bound to say that, upon the whole, if it had been a question of going into action, I should have fired the broadsides by word of mouth rather than by electricity. I found that you could make special arrangements that gave you considerable control over the guns, though they were distributed in two batteries. Instead of having, as is commonly fitted in the ships, a tube to the upper battery and another tube to the lower, I threw the two tubes into one, and made openings into the same tube, one in the upper battery and one below it. No confusion arose. When I put my ear to the tube, I heard what was going on in both batteries, and could separate what was going on; and my orders to one battery or the other were never confused in any way. From the top of the single tube I carried a flexible india-rubber tube to my mouth, and gave the order through the tube direct to the guns, as I looked along the director. I found the firing was as sharp, as far as I could judge, as electrical firing, and that in passing the target we generally made very good practice. On the other hand, there is no doubt whatever that the firing gear, the tubes, and battery, with which I was supplied, were very inferior to what they are now. I think, as Sir Spencer Robinson puts it, we must recollect that the whole system of electrical firing is still in its infancy; and I can conceive I may go to sea in another ship fitted on a newer principle, and that the whole of my views as to word of mouth firing and electric firing might undergo a change. In the few remarks I made on the paper last time, I drew attention to the fact which Captain Custance has dwelt upon also to-day, that there was in every one of Admiral Randolph's diagrams a perfect study. Since that paper was read, I have been applying myself in my leisure time to the study of some of those diagrams, and I have not as yet got much beyond the first one; and it is of that one that I propose to speak.

I am going to suppose, in the first place, that B, which represents the broadside ship, waits, as in the Admiral's diagram, until he arrives within 800 yards of the A, and sees him turn off to port. But now the Admiral makes the A come down, and the B follow him on his starboard quarter, and he supposes that that will be the condition in which B would naturally go. Now, many years ago, I had quite decided in my own mind that that was certainly a wrong position for a ship depending on her broadside to take up; but if she once got there, and had not a superior speed, I know of nothing that she could do in following her enemy up but to give him alternate broadsides, allowing the distance to lengthen as she went on; and the tactic of the B would be just that shown in Diagram A. She would be receiving

from time to time shot after shot—single shot—as the A went on, while she herself would be turning round in this form, yawing round, and getting her alternate broadsides to bear as she went on. The result of a five minutes fight in this form is seen

DIAGRAM A.



Scale $\frac{1}{6}$-inch = 100 yards.

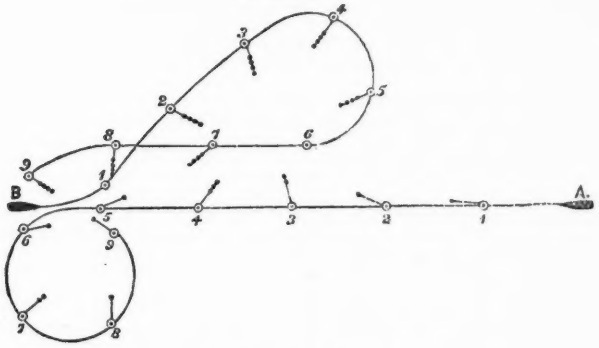
Speed, 10·4 knots. Figures denote minutes.

to be that B will fire twelve shot while only receiving nine. Directly B has fired her broadside, either independently or as a broadside, she puts her helm over, fires her other broadside, and follows up in that way. Of course, the distance goes on increasing; but if you take it for any given number of minutes, she will put at least twice the number of shot into A that she is likely to receive herself. This is not a new idea with me, because, ten or twelve years ago, I used habitually to practise this very movement, as being one of those that it would be necessary to adopt in this case, and I always found I made very fair practice at a target, both turning towards the target and turning away from it.

Now I must go back to the beginning, because I deny altogether that a broadside ship, represented by the B, wishing to use her broadside guns, and having no end-on fire, would ever allow herself at first to come as near as 800 yards end-on to the adversary. I have always held, and in a paper read before this Institution I pointed out, what would be my tactics—that at 2,000 yards I should turn off four or five points, so as to bring my broadside to bear, and make my enemy show his colours. Now I will place A and B so, 2,000 yards apart (Diagram B). I take it that all admit it would not be much use firing at a greater distance than that—not because your shot would not damage if they hit, but from the very small chance there would be of their hitting. At that 2,000 yards my B would certainly turn off four or five points, say to port, to bring her broadside to bear. Now we will say that B does that, and turns, as the "Thunderer" does, five points in about a minute. We will say, for the sake of argument, that these ships have equal speed, each going at 10·4 knots. In that time, while the B is turning five points to port, the A, depending

on her end-on fire chiefly, advances to the point marked 1 (Diagram). When I had got as far as that, in beginning this diagram over again, I began to think I might possibly have under my hand, if I only worked it out, the basis of the war game,

DIAGRAM B.



Scale $\frac{1}{6}$-inch = 100 yards.

Armament—A, 8 Guns: 4 End-on, 4 Broadside; B, 8 Guns: all Broadside.
Figures denote minutes.

and I believe, as far as I can tell, that I have got it, that is to say, that it is completed; and I propose now, with your permission, to run through a little action between these end-on and broadside ships, starting from this first point. Of course, in making a war game, which is to be a real game as well as a source of instruction, it is necessary to surround yourself with more conditions than would actually be the case in warfare. For instance, taking the "Thunderer" at this speed as my basis, we know how much she will turn in a certain time, and the ground she will cover in turning, and we also know what ground she will cover going on the straight; but, to do all that, it is necessary that she should always put her helm hard over. To make the game, the first condition is that both ships must put their helms hard over, because if we allowed them to give other degrees of helm we should have curves that we know nothing about, and we could not tell what would happen. We then must assume a period for the move, and I take the period at a minute, or I take Admiral Randolph's data, that for ordinary guns you must not expect to fire at a greater speed than one round per minute per gun. Now, of course, you can get over a certain amount of ground either in a straight course or turning in your minute, or at the end of your minute you can fire your gun, but you cannot fire the same gun again until your minute is completed. There is another way in which we have to control these ships in a manner in which they would not be controlled in actual war—that is, we must keep them at their speed. They must keep their speed throughout. Well, now, at this point (1) (Diagram B) B has made his move, and he has been asked "Do you fire?" "No," he says, "the distance is too "great, 1,350 yards." Then you come to A for his next movement, and you ask him, "Do you fire?" "Oh, yes, I have got my end-on gun; I am going to fire; I "fire my starboard bow gun." I should say, for the sake of simplicity, I have taken these ships as having eight guns only. B mounts four guns on the broadside, training three points each way. A has two guns on each broadside, with two guns firing from right astern to within six points of the line of keel, and right ahead to within six points of the line of keel.

A has now fired his one shot at B, and he chooses to go on. That finishes his move, and he fires again at (2). While he is making his move, B has gone on

further to port, and comes to the end of the second minute at (2). Now he is asked "Do you fire?" and he says, "I fire now," and he fires four guns, either as a broadside or independently, as the case may be. That is left to the discretion of the commander.

The CHAIRMAN: Would A fire two guns?

Captain COLOMB: Unless your fire crosses, he cannot expect to fire the two.

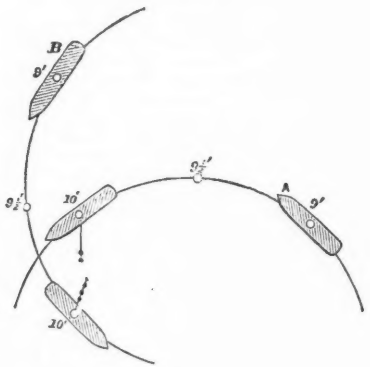
The CHAIRMAN: Although the ship is right ahead?

Captain COLOMB: Just at the first she might, but she will have to yaw to do it.

Admiral RANDOLPH: The datum was there were to be two in the line of the keel.

Captain COLOMB: But, as a matter of fact, unless your guns cross, it is almost impossible that you can fire both. B now says, "I will alter course two points and "steady my helm." The turn happens to take him half a minute, and then he steadies his helm, and fires his broadside of four guns at this point (3) (Diagram). Now we find that A's two broadside guns bear, but not his bow gun; his bow gun is out of action. He therefore fires his two guns. B now proposes, after he has got up a certain distance, to put his helm a-port, to go right round after A. A continues his course, because he wants to get his after gun to bear, and he finds he can at that point (4) (Diagram) bring his broadside guns and his after gun to bear. In reply he receives four guns from B at this point. I do not think I need go on with the battle. You see how by continuing it in this way, by measuring the exact distances, by making minute moves, by taking the guns which will bear, you get between those two ships something very near the exact facts that would happen between two "Thunderers," armed as these two ships are. They go through a variety of movements, and at last A, at 9, having got within 400 yards of B, says, "I will ram." But before that phase of the battle comes on, we have to calculate to see what the result would have been for the two ships as to the artillery fire; and to go no further than the number of shot fired, I find that the broadside ship (and I believe I have been doing everything I can for the end-on ship to give him the full benefit of his guns), the broadside ship fires 28 shot for the 13 the end-on ship gives him, because

DIAGRAM C.



Scale $\frac{1}{6}$-inch = 100 yards.

the broadside man can concentrate his whole energy on keeping his four guns to bear, whereas the end-on man is divided between his desire to keep his two guns on his broadside, his after gun, and his foremost gun to bear, and we find that some of his guns are thrown out of action, when in the case of B they all remain in action. But ultimately A, finding himself, as he thinks, near enough, says, "Now, I shall

"ram." As soon as that is said, continuing the game, the umpire plots the ships on a scale three times as large. When you come on to the large scale, you have to reduce your time for a move. As you consider that when the distance is great between ships, you can take a minute to consider, but when the distance becomes small there is no time to take a full minute. The move is therefore reduced to 30 seconds, and the ships are plotted on the larger scale (Diagram C). A having intended to ram, keeps her helm hard a-starboard. Then B comes on, and in the result we find these two "Thunderers" exactly miss one another. There are not ten yards between them, and it has been absolutely impossible to ram. All A can do is to reduce his speed, and if so, B gets further ahead. At the last moment, however, the bow gun of A is out of action; he fires his two broadside guns, and receives in return the four guns of the broadside ship. I believe I have, as far as I can tell, fought out my battle, giving each ship the full advantage I can, but I have fought it out by confining them absolutely to the conditions of the "Thunderer," and I find that, so far from being checked in my desire to suppress as much as possible end-on fire, the results in a duel between two ships are so enormously in favour of the broadside plan that in the end I find myself stronger than ever. I should say I have prepared scales for fighting this game, and I have every reason to hope that we may see it published. I have partly made arrangements for it. I think they will be concluded. It will not be expensive, and it is astonishing what a good game it makes when you come to play it out. You are tied to time, you must make up your mind in a minute, and it becomes exceedingly hard to make up your mind when you have the paper before you. As time goes on, if we get anything like a result from it, such as I hope, I believe we may add new scales as we get new data, and that ultimately we shall get something which will not only be a very pretty game to pass away leisure time, but every move of which will be of some real advantage in teaching us what naval warfare is likely to be.

Commander CUSTANCE: Commander Wilson has a game very much of the same sort.

Admiral RANDOLPH: I will first refer to the remarks of Sir Spencer Robinson, thanking him very much for his courteous expressions towards my paper, and asking him whether I understood his argument to be in favour of many guns rather than few.

Sir SPENCER ROBINSON: Yes.

Admiral RANDOLPH: I thought you first announced your principle as the reverse, but your argument afterwards seemed to meet mine, which is in favour of many side guns, rather than few.

Sir SPENCER ROBINSON: My only condition is that the small number of guns should be sufficiently heavy to penetrate the armour.

Admiral RANDOLPH: If it is a matter of penetration the larger projectile will not produce much more punishment than the smaller one. The explosion of the larger shell will produce more mischief, but if it penetrates as a shot, it will only make a little larger hole. Therefore, I think the principal advantage in the heavier projectile is for its smashing rather than its penetrating power. On the subject of electricity, it was with great pleasure I heard Sir Spencer Robinson express his views, and it would be presumptuous on my part to oppose any opinion of my own; but I must ask Sir Spencer Robinson to be so good as to remove my principal objection to automatic firing, which he certainly has not done, which is this: he himself admitted it depends entirely upon the roll of the ship. Now ships have frequently no roll at all. Sir Spencer Robinson put it at six, eight, or ten degrees. It is a very rare thing for a ship to roll so much. In harbour, in such a place as Besika Bay or Aboukir Bay, Copenhagen, and various other scenes of battles—almost any battle you can name, barring Trafalgar—the rolling would not exist. I also submit, with all due deference, that when it does exist, there is an insuperable difficulty in getting a roll synchronous with the object being on. Other gentlemen assert that there is not the slightest difficulty whatever. You predetermine your elevation, say, for 500 yards. The enemy is a ship at sea, and you assume the power of bringing him 500 yards from you. I do not think there is one Captain in fifty would make sure of passing at 500 yards. Neither can I get over this: whatever improvements may be made in electricity by-and-bye, there is the very great objection of changing from one system to

the other. Commander Custance rather attacked me for attacking Lord Nelson. I am sure I never meant to make such an attack as he has defended him from. As for his tactics at Cape St. Vincent, I do not know what it means; he was there only commander of his own ship. At Trafalgar I do not know about his masterly tactics; but if I read history right, I fancy the ships were got into action much as the very light wind would enable them, and the ruling principle was, no ship could go very wrong if he got alongside of an enemy, and instead of carrying out his own wishes, he said how nobly Collingwood was doing the work for him. But I did not mean to attack him or Collingwood either. Commander Custance was good enough to say all my premisses were wrong, and therefore the conclusions were wrong, and he said he would not argue except upon exact data, and that the number of hits was a mathematical question, capable of being ascertained mathematically with positive accuracy, and also the time you would be under fire. He quoted some, I believe, Russian statistics, and told us he could mathematically and accurately ascertain the hits he could make in action.

Commander CUSTANCE: They are not from actual practice; they are purely theoretical conceptions.

Admiral RANDOLPH: I understood you to say the number of hits made is actually a mathematical question, capable of being accurately determined. I suppose that is from ascertained practice in peace, but whether you can form any conclusion as to what it will be when the target is firing at you I leave you to decide. Another question he asked was, on what data I founded the opinion that shots were to be fired at the rate of one round a minute? I never formed any such opinion; I expressly said I did not care what the number of rounds were, if you would only allow the same on the other side. You may fire 50, if you let the enemy fire 50. There was so much said in so short a time that I am unable to answer all the things in detail, but there was a great deal said about the accuracy of these diagrams. By those circles I claimed to show, not the number of shots that can be fired in a minute, nor the number of shots that can be fired during a circle, but the number theoretically possible, supposing those ships to turn in the smallest circles, and on an average the circles drawn represent those in which the ships could turn. Ships such as the "Thunderer" are exceptions, not the rule; but if they do not apply to the "Thunderer," they must be regulated and modified accordingly. Commander Custance said facts were only to be determined by experiments. Now, I am not aware how we are to experiment. I do not wish to try the experiment of having the enemy to attack me, and see what I can do in the face of his fire. Captain Colomb represents the B ship coming down and passing under A's stern. That is exactly what is shown on my diagram. Here (*pointing to diagram*) he says B is to zig-zag about in this way, and A is to go on straight, he admits, increasing the distance. How long will it be before A gets out of shot? A, also, presents his feather edge to B's broadside. Can B possibly get a second broadside at him, and, if so, at what range? If B puts his helm a-starboard, and passes under A's stern, A stops or slows, and the result is represented at the right-hand side of the diagram. My answer to this war game is simply this: A will not go in a straight line; if B goes over there, A will put his helm a-port, and ram him.

Captain COLOMB: It is too far off, 2,000 yards.

Admiral RANDOLPH: When B turns here the radius of the circle of turning is 300 yards; B advances 300 and A 300, so that they are 1,400 yards apart. A is exposed end-on to B's fire, but A quietly puts his helm a-port, and all this beautiful part of the game is quite wiped out. I think Captain Colomb seems to ignore ramming altogether; he makes allowance for nothing but artillery fire, whereas A depends principally upon his ram.

I owe an apology to Captain Long for not having answered his question last time. My paper is an argument entirely in favour of end-on fire and the ram, against the broadside—the principal value of the formation is the fact that it enables every ship to deliver its fore and aft fire and broadside, also clear of its friends. That is the simple object, that every ship can fire its bow and stern fire, and both broadsides, without hurting its friends. That, so far, goes entirely in favour of end-on armament. Commander Custance said, the only fault of my attack upon electric firing was, that it was not strong enough. He further refuses to argue upon any

premisses not proved. I submit that there was not a single attempt at proof of any of his premisses—they were all assumed. He mentioned a hazy notion of one of his friends, who talked about engaging at two miles off. Now, I submit that is utterly inapplicable to any case in my paper, when I put the engagement at the outside at 600 or 700 yards. I do not think there is anything further with which I need trouble you.

The CHAIRMAN: I am sure you will allow me to thank Admiral Randolph in your name for his admirable paper. The naval war game which Captain Colomb promises us will, I am sure, be most welcome to all of us, and it may lead to something which may be of still further advantage. The Russians with their gun-boats and large steam launches, go through most carefully the evolutions performed in real warfare, especially ramming the vessels being carefully practised; and what they are doing in reality, we are only talking of doing on paper, but if doing this on paper leads to more practical methods, I am sure it will be a great advantage to us all.

LECTURE.

Friday, January 31, 1879.

ADMIRAL SIR ASTLEY COOPER KEY, K.C.B., F.R.S., in the Chair.

THE ELECTRIC LIGHT.

By WILLIAM HENRY PREECE, M.I.C.E., V.P. Soc. T.E., Electrician General Post Office.

THOSE who live in the present day have good reasons to be thankful for the luxuries and comforts which science has bestowed upon them to improve their health, to cleanse their bodies, to economise their time, to transport their frames and their thoughts from place to place, and to enable them to live, move, and have their being in pure air, in cheap clothing, and in bright light. In days of old that which has given us soap, steam, gas, and electricity would have been deified, but the day for the apotheosis of Science has not yet come. Science remains the delight of the few, the fear and scorn of some, the mystery of many. The finest disciplinary agent for the mind, the great searcher for truth, the great inspirer of awe and reverence, remains untaught in our schools, unappreciated in our legislative assemblies, unused in our pulpits.

If any one wishes to know how our great-grandfathers moved about in the dark, let him go to the National Gallery, examine Hogarth's pictures, and wonder how the pleasures of society could possibly be conducted in such obscurity. Boswell tells of "a very fashionable "baronet" who preferred "the smell of a flambeau at the playhouse" to the fragrance of a lovely May evening. Even now our noses are sometimes assailed by the sputtering tallow and the smouldering snuffers of our childhood. Prior to 1832 our candles were taxed, and the poor were compelled to dip their own rushes. Now, thanks to the greater brilliancy of gas, exciting emulation and enterprise, the removal of excise restrictions, the ingenuity of Palmer, Price, Field, and others, our poor can luxuriate in greater luminous brilliancy than the nobility of a hundred years ago. Oil lamps were not introduced

into the streets of London until the reign of Charles II, and then they were only lit from Michaelmas to Lady Day, and only from darkness till midnight even then. The poet Gay speaks of the public streets—

> "Where oily rays,
> "Shed from the crystal lamp, o'erspread the ways."

And there are many of us in this hall who perhaps can remember towns which were so lit to within a comparatively recent period. Gas was introduced in 1802 by Murdock, and it was employed practically for the first time in lighting up Boulton and Watts' new steam engine manufactory in Soho, Birmingham. The electric arc was discovered about the same time by Sir Humphrey Davy, so that we have this strange fact, that steam, gas, and the electric light were introduced at the same time.

Thus the electric light is no new thing. It has remained the plaything of the philosopher for seventy years. It has scarcely made any advance within this last twenty years, and, in reality, we know nothing more about it now than we did in the year 1862 when it was exhibited at the International Exhibition. How is it, then, that there has been such a scare amongst those who are interested in gas? In the first place, those who visited Paris were charmed and delighted by the brilliant display made at enormous cost by our friends on the other side of the Channel, an effect which was very much enhanced by the clearness and beauty of the magnificent new street that the Parisians had just constructed. Again, the tremendous sensation produced by the telephone and phonograph had excited astonishment at the novelties produced on the other side of the Atlantic, and wonder at what was next to appear; so that when a newspaper telegram was received announcing that Mr. Edison, the inventor of the phonograph, had made some new discovery in electric lighting, and was able to multiply the light *ad infinitum*, so as to entirely displace gas, timid gas shareholders lost confidence in their property, and threw their stock broadcast upon the market.

It is amusing to find how these scares have been repeated periodically. We read in 1848 and 1849:—"Very recently, how much un-
"necessary alarm has been created by a few cleverly written news-
"paper paragraphs about the electric light. Nothing could more
"clearly demonstrate the sensitiveness of gas proprietors than their
"conduct on that occasion. In the largest and most prosperous com-
"panies, both in the metropolis and the provinces, shares fell 25 to 30
"per cent., and in a few days, whilst contracts were deferred, and
"works actually in progress were hastily suspended."

Again, in 1857, we read that M. Jobart, addressing the Belgian Academy of Sciences, said:—

"I hasten to announce to the Academy the important discovery of
"the dividing of an electric current for lighting purposes. This
"current, from a single source, traverses as many wires as may be
"desired, and gives a series of lights ranging from a night lamp to a
"lighthouse lamp.

"The luminous arc between two carbons produces, as is well known, "a very intense, flickering, and costly light. M. de Chanzy, who is a "chemist, mechanician, and physicist, is thoroughly conversant with "the latest discoveries, and has just solved the problem of dividing "the electric light.

"In his laboratory, where he has worked alone for the past six "years, I saw a battery of twelve Bunsen elements producing a con- "stant luminous arc between two carbons in a regulator of his own "invention, this regulator being the most simple and perfect I have "ever seen. A dozen small miners' lamps were also in the circuit, "and he could at pleasure light or extinguish either one or the other, "or all together, without diminishing or increasing the intensity of "the light through the extinction of the neighbouring lamps. The "lamps, which are inclosed in hermetically sealed glass tubes, are "intended for the lighting of mines in which there is fire-damp, and "for street lamps, which would by this system be all lighted or put "out at the same time on the circuits being opened or closed. The "light is as white and pure as Gillard's gas, with which it has one "point in common, viz., its production by the incandescence of "platinum. The gas-pipes are replaced by simple wires, and no "explosions, bad smells, or fires can take place."

In 1862 we had a grand display in our own Exhibition. The electric light was used during the erection of Westminster Bridge in 1862–3, and the metropolis was illuminated in several places by its means during the rejoicings attending the marriage of the Prince of Wales in 1863. In 1876 we had a very good display at the Loan Exhibition in South Kensington. Now the public mind is becoming so educated to the use of the electric light, and manufacturers have taken up the matter so warmly, that we may probably look upon the electric light as being the accepted light for certain purposes.

Now let us ask ourselves this question—What is light? It is one of those forms which that all-pervading agent, called energy, assumes to render matter evident and useful. Matter, by energy, is compelled to assume certain motions which at one time give us those effects called heat, at another time light, at another time electricity, and so on. But heat and light are identical in character, though different in degree; and whenever solid matter has imparted to it motion of a very high intensity—in other words, when solid matter is raised to a very high temperature—it becomes luminous. The amount of light is dependent upon the height of this temperature; and it is a very remarkable fact that all solid bodies become self-luminous at the same temperature. This was determined by Daniell to be 980°, by Wedgewood 947°, by Draper 977°; so that we may approximately assume the temperature at which bodies begin to show a dull light to be 1,000°. The intensity of light, however, increases in a greater ratio than the temperature. For instance, platinum at 2,600° omits forty times more light than at 1,900°. Bodies when raised to incandescence pass through all stages of the spectrum; as the temperature increases, so does the refrangibility of the rays of light. Thus, when a body is at a temperature of—

Temperature.	
250°	it may be called warm.
500	„ „ hot.
1,000	we have the red rays.
1,200	„ „ orange rays.
1,300	„ „ yellow rays.
1,500	„ „ blue rays.
1,700	„ „ indigo rays.
2,000	„ „ violet rays.

So that any body raised to a temperature above 2,000° will give us all the rays of the sun. Inversely, the spectroscope may thus be enabled to tell us the temperature of the different lights, and it is, perhaps, because some lights do not exceed 1,300° that we lose all those rays beyond the yellow.

Now, in all substances which we use for the production of light, we have a combination of hydrogen and carbon brought into contact with the oxygen of the air. In the first instance heat is applied to the wick, or to the escaping gas, and we produce, first, a separation of the hydrogen and carbon, and then a combination of the hydrogen and oxygen of the air, which produces water and greater heat, and this greater heat renders incandescent the carbon particles which have been set free, and which combining with oxygen form carbonic acid. The products of combustion are thus, in all cases, water and carbonic acid, but, in the case of poor gas, there are certain impurities set free, such as sulphuretted hydrogen, difficult to remove.

In estimating the value of a light, it is necessary to have some standard by which that light can be compared. In England, the standard light has been defined by Parliament to be that of a sperm candle, of six to the pound, consuming 120 grains per hour. Compared with this standard, a Carcel lamp gives 9·3 candles, the ordinary street lamps of London give 12 candles, a good Argand burner gives 20 candles, the oxy-hydrogen light gives 200 candles, and the splendid 6-wick lamp, used by the Trinity House authorities in our lighthouses, gives 722 candles. There is no doubt that this is a very convenient standard to work by, and it is as useful in comparing light as the foot or the gallon in their respective uses. One cubic foot of gas consumed per hour, gives a light-power of 3·5 candles, but the light-power per cubic foot consumed increases with the amount of gas consumed at the same time. For instance, if 111 cubic feet of gas be burned per hour, we get a light equal to 500 candles, in which the unit power is raised to 4·5, *i.e.*, in such a burner each cubic foot of gas gives 4·5 candle power.

It is worth knowing that every human being vitiates 3,000 cubic feet of air per hour, and each gas jet, burning 3½ cubic feet per hour, vitiates 5,000 cubic feet of air, and it is interesting to compare, in this respect, the different materials used, which are shown in the following table, and to which has been added the relative cost of production :—

Material.	Carbonic acid, cub. ft.	Heat.	Relative cost.
Gas.....	4	32	1
Oil.....	6·4	63	7·1
Tallow candles	10·1	100	10·0
Wax	8·3	82	30·0

From this table it will be noticed, perhaps to the surprise of some, that in every respect, whether we regard cost, carbonic acid produced, or heat evolved, gas is very much superior to any other form of luminant.

Light being merely due to matter being raised to a high temperature, it follows that the best light is that which concentrates the greatest amount of heat on the smallest quantity of matter. If, for instance, 1,000 red-hot pokers were brought into this hall, we should not be able to see each other by their means, but if the heat distributed upon those pokers were concentrated on a pill, we should have a light which would outvie the electric light. From this it follows that, to produce the electric light, we must first produce heat, and, secondly, we must supply matter. Now heat, light, and electricity, being mere forms of energy, it must, according to the laws of energy, be absolutely essential, before we can produce those effects, to have the energy in some other form, in some other place, to be converted into those forms. In practice, there are two modes by which this is done. First, the potential energy of zinc is converted in an ordinary galvanic battery, first into electricity, then into heat and light; or, second, the potential energy of coal is converted in a furnace into steam, then, by the agency of an engine into motion, thence into electricity, and, lastly, into heat and light. We will describe each of these modes.

First, the battery. Here zinc is consumed in a voltaic cell, and in its consumption it gives out an amount of energy which appears in the shape of an electric current. This electric current can be reproduced as heat either by rendering a fixed wire incandescent or by leaping across an air space, carrying with it small particles of carbon which are rendered incandescent through the violent temperature that they assume. The latter mode is called the electric arc, and it was discovered by Sir Humphrey Davy, in 1808, by means of 2,000 cells, which were supplied to him through the liberality of the members of the Royal Institution. In 1843, Grove produced his marvellous battery, which was able to produce as great effects with 60 or 70 cells as Davy produced with his enormous battery. In 1843, Sir William Grove used 50 cells to produce a light equal to nearly 1,500 candles, and by this means was able to illuminate the hall of the London Institution. In 1846, our Parisian friends used it for illuminating the stage of the French Opera House, and no one has visited or listened to the lectures at the Royal Institution without finding such a light occasionally used for illustrating the lectures. The use of a battery for the production

of light is, however, attended with difficulty; it is troublesome to maintain in action for more than an hour, and the materials it consumes are expensive. Hence, the electric light produced by the battery has never been of practical value.

The second source of electricity is coal consumed in a furnace. In the year 1831, Faraday showed how it was possible to convert mere motion into electricity when this motion was imparted to a coil of wire in the neighbourhood of a magnet. Energy is always consumed when work is done. It is always consumed when any resistance is overcome. When we move about we overcome the resistance of gravity. When a wire is moved in the neighbourhood of a magnet, we overcome the resistance due to magnetic attraction. In the first case we experience heat in our bodies, in the second case we experience electricity in the coil; and when we move such a coil by means of our arms we directly convert the muscular energy of our arms into the electric current. Pixii, in 1832, Saxton, in 1833, and Clark, in 1834, took advantage of this discovery of Faraday to construct machines in which currents of electricity were produced either by the rotation of coils in the front of a magnet, or by the rotation of a magnet in front of coils; but it was only in 1856 that Professor Holmes produced powerful uniform and continuous currents always flowing in the same direction, which were of sufficient strength to produce the electric light. He was assisted in his labours by the great Faraday, and is certainly the father of lighthouse illumination by electricity. His apparatus was shown at the International Exhibition of 1862, and it was practically established at Dungeness in the same year for the illumination of that lighthouse. Holmes's machine was dependent upon the motion of coils of wire in the field of a powerful permanent magnet. A company was formed in France for the production of the electric light by means of Holmes's machine. This company was called the Alliance Company, and Holmes's machine is known in France as the Alliance machine. In this case the energy of the coal consumed in the furnace, which was converted into steam, and then into motion, became, by the resistance overcome in the magnetic field, powerful currents of electricity. But the proportion of energy transformed into electricity was a very small portion of that consumed in the furnace. Indeed, in the very best steam-engines only a small fraction of the energy is utilized, and there remains great room for improvement in the utilization of that fraction of the energy which is found in the steam-engine. In the very best steam-engine, consuming from three to four lbs. of coal per horse-power per hour, scarcely one-tenth of the energy is utilized, and it is a matter of great consideration to make the best use of this fraction of the energy of the coal.

But the use of permanent magnets for the production of a magnetic field was supplanted by the use of electro-magnets. Siemens in 1854 had produced an entirely new armature, which enabled electricians to considerably augment the currents produced by the rotation of a wire; and Wilde in 1863 found that it was possible, by using the current produced in a small magneto machine to excite the electro-magnets of a much larger electro-magnetic machine, to produce currents of

electricity that could be magnified enormously. In 1866 Varley, Wheatstone, and Siemens almost simultaneously showed how it was possible to dispense entirely with any permanent magnet, and make use of the residual magnetism contained in the passive iron, which, acting cumulatively, would produce currents of enormous strength. In 1870 Gramme, in Paris, constructed a machine on this principle, in which continuous currents in one direction were produced, and about the same time Hefner von Alteneck, in Berlin, improved on Siemens' machine in such a way as to produce a machine which is pre-eminent and nearly perfect. In 1877 Gramme produced another machine, producing alternate currents in opposite directions, to meet the wants of new electric lights. But of all the machines that have been produced in Europe, Siemens' perhaps remains *facile princeps*, while Gramme's machine runs it a very close second. In America two or three admirable machines have been invented, the best of which, and the only one of which we have seen in Europe, is the Wallace-Farmer machine, a very powerful and excellent one.

The following table gives a list of these machines, with measurements of the light produced by them per horse-power, as far as those particulars have been collected :—

Machine.		Light per horse-power.
Siemens		1,254 candles
Gramme		758 „
Wallace-Farmer Brush	America	about 400 „
Holmes (Alliance)		476 „
De Meritens..		543 „

It will be seen that in recent years great advances have been made in the economy of the production of light by these machines, but the statements made by interested persons as to the power of the light produced by their machines must be taken *cum grano salis*, while the power consumed is almost invariably understated. The figures inserted in the above table have been gathered from two admirable reports : one made by Mr. Douglas, and by Professor Tyndall, for the Trinity House, and the other made by a committee for the Franklin Institute, in Washington.

It is worthy of note that Sir William Armstrong, at his residence near Newcastle, has utilized the energy of a waterfall to produce these currents, which are brought into his library for the production of light. Mr. Wallace has done the same thing in America.

Now, it has been stated that the heat generated by a current can be utilized for illumination, first in the form of incandescence, and, secondly, in the form of the arc. The first form of incandescence is that assumed by a fixed wire of given length when a current of given strength is passed through it. In 1844 Dr. Draper, of New York, utilized this principle in the way that has been described in the earlier part of these notes, and from that day to this the patent lists of both America and England are full of the names of those who have endeavoured to utilize the same principle by using either platinum, an alloy of

platinum and iridium, or carbon, so as to make it available for lighting purposes. The latest and best form is probably that shown by Werdermann, whose light is remarkably steady, though requiring a considerable expenditure of power to produce it.

Dr. Tyndall has shown that the visible rays of an incandescent wire bear to the invisible rays a much smaller proportion than in the arc, and it is generally assumed that for the same current the arc will give at least $2\frac{1}{2}$ times greater light than an incandescent wire; in fact, Dr. Tyndall's figures are as follows:—

	Visible rays.		Invisible rays.
Gas	1	to	24
Incandescent wire ..	1	,,	23
The arc	1	,,	9

But the ease with which a wire can be maintained incandescent has led many to believe in the possibility of the extreme subdivision of the light. There is, however, no difficulty in showing that this hope is quite inadmissible, according to our present knowledge. There is, however, one point in which it may be possible to make use of an incandescent body for light-giving, and that is in the case of iridium. The fusing-point of that metal is almost beyond measurement, and were it possible to produce currents strong enough, there is no doubt that a bright, steady, brilliant light would result from its use. One of the grandest features in Dr. Tyndall's lecture at the Royal Institution on the electric light was the brilliant glow produced in incandescent iridium by the Wallace-Farmer machine.

The electric arc is to all intents and purposes a little sun. We have in it the production of intense heat and the transference of particles of carbon, raised to incandescence, across the air space.

When the two carbons are placed in contact with each other, we have a species of microphonic effect. They make a "bad contact," heat is generated, the air is practically rendered a conductor, the incandescent matter is transferred across this space, and we have not only the production of intense heat and light, but we have the transference of matter from the positive to the negative carbon. Hence we have one of the carbons consumed at a greater rate than the other, and thus the light does not remain a fixed point in space. It was soon found that some species of regulator was required to keep the point of light always in the same place. This was effected by Foucault in 1848. He gave the two carbons a motion equivalent to the rate at which they were consumed. Serrin improved on this, and the forms of lamps based on this principle are almost innumerable. The only real departure from the principle introduced by Foucault of any practical value is that of Wallace, who places two plates of carbon opposite to each other, the distance apart being regulated by the attraction of an electro-magnet.

These forms of regulators, as a rule, require the addition of complicated machinery to maintain the unequal motion of the points of the carbon, but Jablochkoff in 1876 made a move in an entirely different direction. He placed his two sticks of carbon side by

side, separated from each other by a layer of insulating material, and, by using alternate currents, he was able to produce an equable consumption of the carbons, and thereby dispense altogether with the complicated machinery such as that introduced in the Serrin lamp. Although this "candle" was introduced by M. Jablochkoff, it in reality had been previously invented by Mr. Werdermann. M. Rapieff also has made a distinct departure on this line, and has produced an exceedingly simple lamp. It is impossible to refer to all the lamps that have been introduced. The writer prefers to confine his attention to those which have been practically under trial.

The requirements of a good electric lamp are, first, intense brilliancy; secondly, great steadiness; thirdly duration. The Serrin lamp has the first kind of excellence; all those lamps based on incandescence excel in the second respect: the Wallace-Farmer light is the only one that attains the third point. The Rapieff is perhaps that form which up to the present most nearly combines the three requisites, but in reality no lamp has yet been introduced which fulfils all three requirements.

The objections to the use of the electric light, are:—

1. The deep shadows it throws.

2. The indifferent carbon that has hitherto been manufactured for the purpose, which leads to unpleasant sounds, to great variation in the intensity of the light, and to waste.

3. The difficulty in distributing the light itself. It is so intense and confined to so small a space that it does not lend itself to distribution like the gas flame which occupies a considerable space.

4. The unsteadiness of the light due to variations in the speed of the engine employed in driving the dynamo machine. There is another cause of variation in the electric arc, and that is, the variation in the resistance of the arc itself, for it has been clearly demonstrated by experiments both in America and in England, that the resistance of the arc varies as the resistances in circuit vary. The following table will show this:—

Current in Webers.	Light candles.	Resistance of arc. Ohms.
10	440	2·77
16·5	705	1·25
21·5	900	1·67
30·12	1230	·54

The light in the arc directly varies as the current, and not as the square of the current as is generally assumed.

Now, in the case of light raised by incandescence, the light will increase as the square of the current. It follows that if in the one case, viz., the arc, the light increases as the current only, and in the other case, viz., incandescence, it increases as the square of the current, a point is reached when the light produced by incandescence will equal that produced by the arc. The difficulty in reaching that point is the difficulty in obtaining a conductor with a sufficiently high point of fusion to resist the effect of powerful currents. Iridium is the only metal that is known to do this, and iridium is too scarce and too dear to be used for the purpose.

The multiplication of the light by Gramme's machine upon the Thames Embankment must not be taken as the solution of the problem of the subdivision of the light. Theory shows unmistakably that to produce the greatest effect we must have only one machine to produce only one light. We know from absolute measurements that such a machine can be used to produce a light of 14,880 candles, and it is possible to produce 1,254 candles per horse-power. But the moment that we attempt to multiply the number of lights in circuit this power diminishes, so that we have on the Embankment lamps giving us a light of scarcely more than 200 candles. The light of the Rapieff lamp in the *Times* office appears to be about 600 candle power, and the Wallace light is equal to 800 candle power. In these two instances six lights are used in one circuit, but we have not here the subdivision of the light, we have, on the contrary, the multiplication of the light, produced by the increased speed of the engine due to the insertion of additional lamps. It is, however, easily shown that in a circuit where the electromotive force is constant, and we insert additional lamps, then when these lamps are joined up in one circuit, *i.e.*, in series, the light varies inversely as the square of the number of lamps in circuit, and when joined up, as in multiple arc, the light diminishes as the cube of the number inserted. Hence the subdivision of the light is an absolute *ignis fatuus*. In the first place no machine has yet been produced which is competent or capable of lighting over 20 lamps; secondly, no conductor is known but copper competent to convey the current required to light these lamps, and copper is an expensive material. Thirdly, no electric light has yet been produced which combines all the criteria needed for a good light.

As to the cost, all that we have seen in print is problematical and one-sided. Invariably the estimate of the light-producing power is too high, and as has been previously stated the expenditure of power is put at too low a figure, so that we have not yet received authentic information as to the cost of the light.

The electric light is unquestionably a wasteful form of energy for the production of light, because we cannot utilize all the heat produced, but only a fraction of it. Under the most favourable circumstances this fraction is but a half, and we can therefore never utilize more than that. But it has shown us what a good light is, what it ought to be, and how it should be obtained. Although the extensive subdivision of the light must be ranked with perpetual motion, squaring the circle, and the transmutation of metals, yet no one will say it is "impossible," but all must say "not yet." Science itself is ever moving, new discoveries are ever coming to the front, and although it would almost seem that in the electrical world discovery had ceased, nevertheless it is impossible to say from day to day what the morrow may bring forth. New discoveries may lead to new applications, and new methods may lead to new developments, but though we hesitate to say it is impossible, yet it would seem in our present knowledge that electricity cannot supplant gas for domestic purposes. For lighting large spaces, workshops, warehouses, railway

stations, docks, extensive areas where work is being conducted, for naval and military purposes, for guarding ships and fortresses by night, it seems admirably adapted. Whatever the electric light of the future may be it will have its own sphere. While the introduction of gas in no sense or form interfered with the production of candles, so it is difficult to perceive that electricity will in any way interfere with gas. It will, on the contrary, rather tend to increase its consumption by giving us a greater appetite for a better light.

The CHAIRMAN: Before I ask your permission to return thanks to Mr. Preece, I should like to know if any gentleman present wishes to ask any question or to make any remarks on the lecture we have heard. Mr. Preece is quite aware that this subject of electric light is especially interesting to us both in the Army and Navy, not because we are large holders of gas shares, or that we are much interested in the lighting of our houses by electricity; but, as Mr. Preece has mentioned, we do use the electric light to a considerable extent in the Navy. All our large ships are fitted with the electric light for the purpose of assisting us in protecting our ships against the attack of torpedo boats, and also for use in fogs (for it is astonishing what power the electric light has to penetrate fog), not for the guidance of the ship itself, but to enable other vessels to see the ship that bears the light. I should doubt the praticability of going down Channel with the electric light at the mast-head on account of the difficulty of keeping it burning so many hours. But no doubt its use is extending in both Services, and will prove of great value. I am sure I may express your cordial thanks to Mr. Preece and those gentlemen who have so kindly assisted him, for the very able and clear lecture he has delivered us.

Mr. PREECE: I regret that I omitted to describe the light used in the Navy. It is Wild's light. Mr. Wild, of Manchester, is one of those men who have marked an epoch in the history of the improvements of the electro-dynamic machines. In 1863 he produced a machine which proved the first step to the powerful machines now in use. He has also produced a light, and he has his light and apparatus fixed on no less than twelve of our men-of-war at the present moment. As regards the question of time, I do not fear that; I am sure the Wallace-Farmer light, if lit when the ship was in the Thames, would be found burning just as brilliantly when the ship passed the Lizard. He has solved the question of durability and has given us a light that will last 100 hours at the least.

Major FARRELL, R A.: May I ask what is the comparison with gas as to cost?

Mr. PREECE: I have left that question to others. The fact is, the experiment on the Thames Embankment is almost a crucial one, and there the most careful record is being kept of the expenditure in every shape and form; and on the result of that experiment will greatly depend the knowledge we shall have of the cost of the electric light.

General Sir EDWARD HODGE: May I ask whether the battery should be in the immediate neighbourhood of the light, or whether a battery, say in Trafalgar Square, could light all the clubs in the neighbourhood.

Mr. PREECE: Not to any great extent. The fact is, on the Embankment the battery is under Charing Cross Bridge, and that lights a lamp close by the Houses of Parliament, at a distance of 700 or 800 yards; and it is possible to extend the light to a considerable distance, it is only a question of the size of the wire. It is done, however, at a cost of loss of power: the greatest effect is produced close at hand. As you increase your distance, so the effect is lost. I ought to have mentioned that the light at the South Foreland was the first light ever applied to lighthouse illumination. It was applied by Professor Holmes in 1857 experimentally at Dungeness, and was practically used under the guidance and recommendation of Faraday, in 1862. It has been at the North Foreland ever since. It is the light of Professor Holmes, who is in reality the father of lighthouse illumination, and I much regret that I omitted to mention him, although I have alluded to him in my notes.

Evening Meeting.

Monday, Feburary 3, 1879.

LIEUT.-GENERAL SIR DANIEL LYSONS, K.C.B., Quartermaster-General, in the Chair.

PERSONAL EQUIPMENT OF OFFICERS ON ACTIVE SERVICE.

By Major T. FRASER, R.E.

IF the destruction of others be the most important branch of the art of war, that of keeping oneself alive is not the least so. This is now more than ever the case, because several things combine to facilitate mobility and increase its importance. Steam and the telegraph are the chief material causes; while, among the great military nations, universal conscription has increased the size of armies, and coupled with the more uniformly scientific study of war, has rendered the launching of armed masses more rapid. The supply of the wants of individuals has therefore become, in some respects, more difficult, and rapidity therein more important.

At the same time, the more complex condition of the modern fight have given an increased value to the leadership of Officers. Everything, therefore, that increases their efficiency, and frees them, on service, from thinking about their personal wants, must promote the working of the machine.

With this object, the following notes on equipment, based on experience lately gained in European and Asiatic Turkey during summer and winter, were printed, in the first instance, in view of what seemed a probable contingency, and have since been revised in accordance with the wish of the Council of this Institution.[1]

To the notes has been added a list of what has been found useful; and to save inquiries, and also the time of those who may have to get their kit in haste, other particulars have been given where it appeared desirable.

[1] In reprinting these notes considerable additions have been made; and the author has to acknowledge the help he has received from Col. W. O. Lennox, V.C., C.B., R.E., and from Mr. F. M. Sandwith, who was on the Medical Staff of the Stafford House Committee.

The first impression that the list of equipment is likely to produce is, probably, that it contains more than can be required. The answer is, that it has been framed to meet a number of requirements: is chiefly suggestive and must be modified according to circumstances. Travellers or Officers working independently of a field force must have some special object in view and have certain difficulties to deal with. In their case, therefore, the carrying arrangements must be made to fit their requirements within reasonable limits; and notably in the matter of food, they may even have to exceed the total amount given in the list; while with a well-found force, a much less quantity would be enough for the Officers who accompany it. Similarly, when a limit of weight is strictly adhered to, as it ought to be, Officers must use their own judgment in selecting what it is best to take. In Egypt, for instance, where it does not rain for more than three or four days in the year, waterproofs are not wanted, nor warm clothing. Again, there are many things that always accompany troops; this relieves the Officer of the necessity of taking them. Indeed, circumstances must in all cases be considered; and it has been happily suggested, I understand, by Major-General Sir Henry Green, that a conference of Officers, who, among them, have had experience in all the countries in which we are liable to campaign, should agree upon and draw up the several lists required in each case.

By the regulations of our Service, based on the carrying power of wheeled transport, Officers are, according to rank, to have from 40 to 80 lbs. of light baggage taken along with them, and in addition about 20 lbs. of cooking utensils for messes of three Officers. They each will further be allowed a bullock trunk to hold about 100 lbs. of personal baggage, which, however, is generally to remain at the base.

In countries civilized enough to have numerous good roads, railways now commonly exist, and the movement of heavy baggage is generally easy from the base to the neighbourhood of the force; but even although the ways admit of wheeled transport, the crowded condition of all the lines of advance often renders it impossible for baggage waggons to keep up continuously with troops, particularly when any emergency makes their movements very rapid; so that even with good roads, and still more so in roadless countries, some modifications will, it is thought, be necessary. Illness and inefficiency in campaigning are not so much due to permanent lack of necessaries, as to the few odd days of extreme hardship and exposure which the absence of all baggage involves. It seems, therefore, best to decide as to what is the absolute minimum for daily use and to take steps never to be without it: benefiting of course by such favourable opportunities as occur, to secure extra comforts.

Bearing this in mind, the things in the list have been put down in the supposed order of importance, and have been classified as:

(A) Those that Officers and others should try to take with them from day to day, and never part with if possible.

(B) Those that, if circumstances permit, they would try to have carried forward, so as to be available whenever the troops make anything of a halt, and the baggage trains close up.

(C) Those that would be left at the base and would serve as a depôt to draw upon as opportunity occurred.

(?) Those required exceptionally and which may be dispensed with most readily.

The list was framed, in the first instance, chiefly to meet the requirements of a mounted Officer when detached. For regimental Officers certain reductions will be suggested.

When troops are continuously in movement, Officers will, it is thought, find that, in the countries such as those in which these notes were taken, the equipment marked A will be about all they can take along with them; and they may think themselves lucky if they can pretty often get at that marked B, to replenish list A.

Remarks on the Materials of a Kit.

Luggage.

All luggage should be marked conspicuously with the owner's rank, name, regiment, and division. The locks should be good, and there should be duplicate keys. Interchangeable keys are convenient.

In civilized countries, where wheeled transport can move with ease, any handy case answers the purpose, and weight is of less extreme importance. But with troops in the field, in countries where roads are few, and the carrying power of those that exist is constantly overtaxed, it is generally necessary that every-day baggage should be carried on pack animals, if you are ever to have it when wanted. With pack animals a small limit of size in the packages is necessary, particularly in difficult country.

Where a little extra weight can be afforded, perhaps the best kind of bullock-trunks are the regulation wicker-basket cases, covered with waterproof mail cloth. Each of these cases should have a wicker-tray, such as women have in their boxes, to save having to empty everything on the mud, should what you want be at or near the bottom. The case-straps have eyes to hook to the pack-saddle, so the cases are easily taken off *during halts*.

White's waterproof lock-up bags are the lightest things that are serviceable, which they certainly are, when a small limit of weight is allowed they are, perhaps, best. They should be furnished with pack-saddle straps, as ropes cut them and injure the contents. They are intended to hold a camp-bedstead: but when this is carried on the march, it is better to have it in a separate waterproof cover to save the trouble of emptying the bag each night in order to get out the bedstead; besides which, mud sticks to the bedstead, and thus goes into the bag, which is inconvenient. This arrangement is a necessity with the bullock-trunks, which are too short for the bedstead. The bottoms of packages should be thoroughly waterproofed, to keep out water in fording rivers; the bed-bags hardly do so.

A soldier's waterproof kit-bag is a useful addition to one's baggage, as, if necessary, it holds enough for a few days at a time.

In moving to the base of operations, mounted Officers may require a saddle-box. This should be light and not very large, and should have

a good lock. It can be left at the base as a store-box. If lined with tin it is all the more efficient for the latter purpose.

A tin uniform case is also a suitable thing to leave at the base, to hold reserves of equipment. Officers who can only carry forward one bag or case might leave a tin case at the base instead of a bullock-trunk.

Horse Appointments.

In most countries horses are small compared with ours, so that for country horses, girths should be shortened three or four inches before starting, say to forty-two or forty inches from buckle to buckle, and head stalls and bridles should also be of small size. The picket-rope with headstall is, of course, always required.

The English hunting saddle is very well in this country, where there is something between skin and bone, but for long-continued marching, the secret of avoiding sore backs is to have a *large bearing surface.* This the Turkish saddle provides, and, clumsy though it be, it causes less damage than our hunting saddle.

Our new regulation saddle with fans seems excellent. Two pockets or saddle-bags (one only is regulation) will be found very useful with this saddle. The pockets should be so strapped to the saddle as to be readily taken off. This is often necessary at the end of the day to secure the contents. If it be necessary to carry a pocket on foot, when for instance a horse breaks down, two cloak straps make a shoulder strap. The new wallets are fixed to the saddle without a girth.

A breastplate is useful in a hilly country to keep the saddle from shifting back. It should be small for foreign horses.

Stirrups should be large enough to be used with the largest boots; for instance, even with india-rubber or fur-lined boots. In cold weather this allows of a non-conductor, such as a bit of sheep-skin, being put on the tread and sides.

The numnah is another product of civilization that should be got rid of. The best plan, it is thought, is to have a suitable horse-blanket to fold under the saddle. For riding, the roller (without pad) is passed round saddle and all.[1] The folding of the blanket should be constantly altered, and all caked dust and sweat should be scraped off; when a sore back is feared, the folds can be arranged to take off the pressure. Whatever happens, the horse has his cover, and for Arab horses in cold weather this is even more important than for ours, as they are accustomed to a much heavier and warmer blanket. Horses accustomed to bivouac, if put for a night or two in a close stable, are apt to catch cold when out again in cold weather. An open shed, however, is an advantage. The Turkish shoe is good in snow, as horses *ball* less with it, and it is more easily replaced in the

[1] Capt. Gill, R.E., tells me that when girth-galls give trouble, he found this roller, used like a racing surcingle, answers without the girths and grips in a somewhat different place. A longish roller is required. The Austrian cavalry use a sort of felt blanket, folded in four, that answers well.

country; it is also a protection on rock. Grease on the soles of the hoofs prevents the snow from balling.

Some form of waterproof saddle-cover is necessary for Officers whose work obliges them to dismount much. In bivouacking, too, it it is important to keep the saddle dry. The new regulation saddle-sheet (4 ft. by 3 ft.) answers the purpose. A nosebag to hold a feed should always be taken on the march. If you are accompanied by a man on a second horse, the man can take it, but if you are likely to part company with him, take it yourself. Heel ropes are very necessary with stallions, and pickets and ropes are required when camping for any time. Instead of carrying heavy wood or iron pickets, if the picket rope have 3 ft. of light chain (with a ring) at each end, then any small bit of wood, or a small faggot, buried in the ground, will do to secure the ends. No horse can draw a picket buried horizontally 8 or 10 inches under ground.

In fly-infested countries, ear-nets for horses are sometimes worth taking.

The pack-saddles in the country often suit the local cattle best. Much depends on girthing the saddle securely, and on dividing the load evenly between the two sides (with as little as may be on top), so as to prevent its shifting. The drivers with pack animals always seem to think that their weight, added to that of the load, helps the animal: this illusion should be discouraged. For a pack-horse, 200 lbs., including pack-saddle, is a very full load. With 160 lbs. a march of 25 miles in a day is an effort; but 20 miles can be kept up for a week. For a long journey 80 lbs., besides the saddle, is enough for small horses. The pace is about $2\frac{1}{2}$ miles, including short halts. When a party starts for a long ride the pack-horses should not be overladen, for, though the food is consumed, some horses are sure to break down, and their loads must be distributed. In buying horses, look out carefully for chronic sore backs and for blindness.

Furniture.

In order to be raised a little above the mud, and as a protection against fever, a light bedstead is a most valuable piece of furniture: and, when troops are stationary, most Officers can manage to have one. White's camp-bedsteads certainly stand very rough usage. The screws should be put in well, or they drop out in hot weather. The Gwenfe hammock, which is independent of all guys, and acts also as a sort of tent, promises to be extremely convenient, and if it prove capable of bearing long-continued rough usage, it might replace the bedstead with advantage.

A hair-mattress is a bulky luxury. If there be transport enough, take a second blanket (not a blanket-bag), which is less bulky and more generally useful than a mattress, and in very cold weather is almost necessary; though by sleeping in all one's clothes, in a blanket-bag with the waterproof cloak over all, one is generally warm enough. Of course the bedstead must often be left behind, and then some much more portable arrangement is required. Cork-mattresses and full-sized air-beds are too bulky to take on one's own horse; and a

separate waterproof sack to lie in seems unnecessary, as the regimental waterproof cloak acts as a ground sheet. All that can be desired is something on which to rest the head and trunk. An air cushion, of from 38 to 40 inches long by 17 inches wide, is large enough for this; and even if it fail as an air cushion, it still acts as a double sheet under the body. A blanket-bag and a kit-bag should he taken with the cushion, so one's bedding only weighs 9 lbs. At night one gets into the blanket-bag, puts on the waterproof cloak, and lies on the inflated cushion; and when it is wet the feet are thrust, blanket and all, into the soldier's bag. If it be very wet, the boots, when off, can be drawn under the waterproof; the head is covered with the nightcap and the hood of the cloak; the helmet may get wet, it dries again quickly. The holsters, saddle, and pockets are kept dry with the saddle-cover; or when the man (and saddle) find shelter, the saddle-cover gives the horse a little protection in addition to his blanket. In very cold weather a buffalo or opossum skin bag is warmer than a blanket, but is more bulky to carry. All bags should be turned inside out each morning and shaken. Should it happen that the climate is such that waterproof cloaks are not carried, then White's 7 lbs. waterproof sleeping sack might take the place of, or be taken with, the air-pillow, if transport permit. Officers who have to write much want a small table and stool (when they can get them). The *pine* tables by White, with thumbscrews to secure them, are convenient; but if it be decided to have mule baskets, a top, in a single piece, of the size of the lid to strap on outside, would, it is thought, be best. A chain-chair is seldom practicable (White's folding chain-chair seems the best of its kind), but a 2-lb. four-legged stool, to fold into a stick, can generally be managed with the baggage.

Sheet india-rubber basins and baths are the most portable, and answer perfectly; inflated ones are not necessary.

In rapid movements, or in extreme cold, or when water is precious, the use of the tub ceases to be a custom, and becomes a ceremony. It is then enough to carry one tub for several people. A small-sized one is preferable. If need be, one can manage with a basin alone.

A small looking-glass is necessary for those who shave; few do.

If tents be used, a pole-strap, and, with each detached party, a hand-axe, a picket-shovel, and a mallet are wanted. Regimental Officers can depend on the pioneers.

A tarpaulin floor-cloth to a tent is a great benefit when it can be carried. In estimating for carriage of tents, take their weight when wet.

Clothes.

In the list, the supply indicated is intended for a few months, the articles being new to start with. If for a longer time, a reserve in proportion should be taken out. In the same way, according to the season, clothing should be thick or thin. In European Turkey the shade-temperature ranges from 100° to 0° Fahrenheit in the year; and though the days in autumn are very hot, the nights are cold. In summer a thin flannel shirt and thin Indian gauze drawers are enough

underclothing. In winter, the thickest woollen drawers (two pairs if possible) and vest, with two thick shirts, or a shirt and knitted waistcoat, are just comfortable; and at such times people wear furs, if they have them. A cholera belt should always be worn—a fine flannel bandage that goes twice round the stomach is best.

For exploring parties, or Officers not on military duty, a shooting-coat with many pockets (or Norfolk shirt), waistcoat, and breeches, is the most convenient dress. These would take the place, on the list, of patrol jacket and pantaloons; and a white cashmere handkerchief does duty for the collar of civilization. In all cases, even when in plain clothes, a regimental waterproof cloak with a hood should be carried; a long light overcoat, with hood, takes the place of a regimental one for men not in uniform. A grey felt helmet, with chin-strap, is the best head-dress, except in very cold weather, when a fur cap with ear-flaps (to be down or up) is warmer, and the head can then be covered with the waterproof hood as well.

If in uniform, the regulation helmet would, it is presumed, be worn. Helmets should be tried on with hair cut short as it would be. The chin-strap should be carefully fitted before starting; it is much wanted in wind. In mid-winter, a forage-cap, with a Canada-pattern fur cover, might be more convenient; at other times a forage-cap does not seem necessary, as the helmet must be carried, and, off duty, the red nightcap can be worn in bivouac.

For duties where much walking is combined with riding, shooting boots and leather gaiters are most convenient, as it is more fatiguing to walk in long boots. The best shooting boots are made with the thickest possible solid *single* soles. These are less stiff than, and last as long as, the heavy soles often used. Nails do not save the soles, and it is better to be without them when riding. The so-called porpoise hide laces are well worth the extra expense. The regulation boot is the best for riding only, except in wet weather, when the drip from the waterproof wets the feet. India-rubber boots are then the most comfortable; they are unfit for much walking, and are slippery in snow, but are a great protection in mud and slush. The best arrangement, perhaps, but one, as yet untried, would be to have a pair of short black waterproof gaiters, ankle high, to cover the whole of the feet down to the soles, with a leather strap under each sole near the toe to keep the gaiters in place; the gaiters would be fastened behind with two straps, one above and one below the spur; they would keep off the drip from the waterproof, and could be at once taken off for walking; they would occupy no space when carried on horseback, and are quite as suitable for shooting-boots as for the others. Boots, if well greased or dressed, will for a time turn water, but not entirely. All boots for riding should be large enough to take two or three pairs of thick stockings or socks. Riding boots should be easy enough to be got on and off without boothooks and bootjacks. A spare pair of boots is by no means a necessity for several days, even in wet weather. Thin canvas boot-bags are convenient for boots carried in luggage. For marching, grease (or soap) rubbed on the feet and on the insides of socks prevents blisters. Always try to change socks at

the end of the day. New socks last longer if darned at the heels and toes.

In wet weather the regimental waterproof cloak is the most valuable article of dress. For a mounted man it cannot be too long; and it should be strengthened at the fork and at the junction of the cape and coat with leather splices. In the latter case, this makes the hook secure. A thin strip of leather round the lower edge of the cloak prevents its fraying. The cloak should have a removable waterproof hood. In severe weather the people of most countries always protect their heads with something more than a cap, particularly when sleeping out, and this the hood does perfectly. With the cloak and with waterproof boots, one can do without a change of clothes for a week or more, even in wet weather.

The regimental great coat is less useful than the waterproof, and is generally assigned to the baggage. In winter, one is glad sometimes to wear it, with the waterproof as well. If the coat be worn without the waterproof, a removable cloth hood is an advantage; but of the two the waterproof hood is the more generally useful. The coat is a serious addition to the weight dismounted Officers have to carry; it should have buttons on the collar for the cloth hood.

The patrol jacket, whether blue or red, should be large enough to allow of two or three shirts being worn underneath. It should have small outside breast pockets on each side, for a watch and pencil. The chains for these pass through holes in the bottoms of the pockets, and are secured to rings inside the coat. With such pockets the articles can be taken out without opening the coat, a great convenience when mounted. All the pockets should be lined with leather, and the side pockets should be large enough for the notebook. If a regimental waistcoat be taken it should have red serge sleeves; then, except in very cold weather, it acts as a mess dress.

Pantaloons for winter should be loose enough for winter underclothing. Dismounted Officers would have trousers instead. Trousers converted to breeches are much more comfortable with gaiters than trousers are. Each brace button should have a duplicate sewn on beside it. If buttons carry away, people don't sew on new ones, but go without. Roomy fob pockets in the pantaloons or trousers, large enough to put one's hand in, are convenient for purse and keys. Black doeskin is the best material for strapping pantaloons.

All pockets should have buttons to close them; as, otherwise, when sleeping in one's clothes, things constantly fall out.

In extreme cold there is nothing like fur. By having patrol jackets and great coats made very large, fur linings can be put into them in the country. Wolf skins are common, and are said to discourage insects. Sheepskin stockings (wool inside) can be used inside the large india-rubber boots, and are a great protection from the cold; they may be long enough to come over the knee. Similar stockings of blanket to go over riding boots are also much used in cold countries.

A cummerbund or silk sash wound tight round the waist is a support in riding (though with a cholera belt is not a necessity, and has certain disadvantages); it also saves the drag of the sword belt

on the stomach. This, too, is lessened by using a sword sling under the coat. A soft leather or broad web sword belt (but with regulation slings) is most comfortable, and, except with a tunic, should be worn if it be permitted. In the Sam Brown belt, much used in India, the sling is of leather, and is worn outside.

The face net used in Ashantee, which can be worn with or without the helmet, would sometimes be a convenience. Though mosquitos are not excessively troublesome, flies are; and in the neighbourhood of carrion are sometimes fatally poisonous. If you have nothing else, a piece of muslin, 3 feet × 4 feet, to lie under is a great protection to the face and hands. Mosquito netting is a slight protection from malaria.

Soldiers must get on with the insects they meet, but explorers may sometimes indulge themselves in the luxury of insect powder.[1]

A pair of slippers of red canvas, with india-rubber sides and soles, is a portable luxury. They rest the feet, and, even in wet mud, keep them dry; by having them, boots can be spared to be dried.

When stationary with one's luggage, the best plan before dining is to dress for bed. That is, put on the other flannel shirt and drawers and a pair of light flannel trousers. Some prefer pyjamas with feet, as being more puzzling to insect life; trousers or drawers should be tied round the ankles, and socks should be worn when sleeping. It is much safer to be too hot than too cold. In hot weather the blanket is only put over the feet and is pulled up when the morning chill comes.

Woollen underclothing should be shaken and aired constantly.

Except when sleeping in a house, all clothing should be put into the luggage each night, to keep it from getting wet with the dew.

Cooking Utensils.

20 lbs. of utensils are supposed to be carried with the baggage for each Officers' mess of three. When they do come up it is important, in campaigning, to be able to cook quickly, and the fundamentals for cooking are—first, a kettle (White's are excellent, being flat, and suitable for wood embers); second, a frying pan.

A tin stewpan is also a convenience where vegetables are found, or rice is to be boiled. The canteen case of galvanized sheet iron serves to boil water for washing, &c. Copper cooking vessels are dangerous. Enamelled plates and cups are very nice, but the cups do not pack well, and when weight is important it is best to have two or three tin cups (with wire handles) which fit one within the other, and to have tin plates as well. Every man is sure to have two or three friends to eat and drink with him pretty often, and they do not travel about with their plates, as a rule.

Hence though, if need be, one can eat with one's fingers and drink out of the palm of one's hand, still, when it is not necessary, much

[1] Pyrethrum Roseum (Savory and Moore), in a sort of pepperpot, answers well. People sometimes put each foot of their bedstead on a piece of paper and put a ring of the powder round the foot; saving the powder each morning. Flies may be driven out of a tent by firing a little gunpowder in it.

comfort is lost without cause, if one is stinted in those matters. So for each man 2 knives, 2 forks, and 4 spoons are desirable. Each canteen should have an eggcup per man, also a salt and pepperbox for the party, and a regular tin-opener (Lund's is the best), and a corkscrew for the servants' use. For frying eggs or meat the cook requires some lard or butter.

Could one be always sure of the canteen, and of firewood, nothing more would be wanted. But to provide for accidents, or the absence of fuel, an Etna is desirable, and should be carried with oneself. The one proposed, boils ½ a pint of water in five minutes, with 1½ dessert spoonsful of spirit of wine, or ¾ of a pint in seven minutes with a little more. The spirit bottle holds about 27 dessert spoonsful. The cap of the burner should be marked as a measure. Whenever firewood is available, it should be used to save the spirit. A newspaper, judiciously used, boils water in the Etna.

Food.

For small parties moving through the country in peace time, meat or eggs can almost always be found; and with troops the bulk of the food will be provided by the commissariat. At the same time, the things put down, being more portable and more quickly used than ordinary rations, are well worth the carriage as a provision against accidents; though, as far as possible, one should live on what one can find, or on the Service rations. It may be laid down as a safe rule *never to mount a horse or to start for a march without having some food with you as well as inside you.* Most of the extracts of meat are unsatisfactory; one wants something more than to be kept alive. Brand's or Kopf's extract, it is quite true, if added, say, to consolidated pea soup, carries one a long way.

One great difficulty is the want of vegetables;[1] pea soup and rice are, in a measure, substitutes.[2]

Ship's biscuit is the best form of farinaceous food, and detached parties should carry all they can of it. Turkish biscuit requires to be soaked, and then heated on the fire to dry it a little; or it may be pounded. Much of the illness of foreigners is due to the bad bread of the country districts.

In warm weather, tea is generally the most agreeable. Tea is now sold, compressed to one-third its original bulk, in ¼-lb. cakes, which keep for a very long time. This form is the most portable. Kopf also makes compressed tea, with sugar and milk, in 3-oz. tin cubes, which are very convenient. Tea should stand in boiling water for eight minutes; for early marching the liquor may be separated from the leaves at night and quickly warmed in the morning. Cocoa and milk is the most warming, but one tires of it. On the whole, coffee and milk is perhaps the best. Half-pound tins (those of the Anglo-Swiss

[1] Kopf's 'consolidated Scotch broth is an excellent preparation, as it contains a large proportion of vegetables.—ED.

Rice one gets in the East requires to be sifted and then washed two or three times before use; it should be soaked for two or three hours and then boiled quickly; then the water strained off and the rice dried by evaporation.

Company are best) should be taken for marching, and a dry spoon should be used to take out what is wanted; otherwise the paste liquefies. Among the luxuries marmalade is the most prized, because it is healthful as well, and seems to check scurvy. Crosse and Blackwell's tinned marmalade and jams are excellent.[1] Brandy (or spirits) should be looked on as a medicine, and should only be used as such: otherwise, it is not a necessity in any way. Country wine is best "mulled."

Soldiers may consider themselves fortunate if they can get some of the above forms of food to make up for deficiencies. There are, however, many others that are suitable. For instance, good Menier chocolate in sticks or slabs is very portable and sustaining. Meat lozenges are also very portable when riding or marching. Sardines in boxes are also convenient, and may, with advantage, be grilled for a change. When one has diarrhœa, Liebig's extract (½ a teaspoonful to a soup-plate) with rice makes a good and suitable soup. Whitehead's soup-squares are also very portable, and make excellent soup.

Fowls can be plucked quickly if dipped into boiling water.

Tinned vegetables, such as peas, tinned condensed milk (that of the Anglo-Swiss Condensed Milk Company is said to be by far the best), tinned butter, tinned oatmeal, and German sausages are among the luxuries one does well to get when they can be obtained at hand. Potted ham and bloater-paste are things to be desired. Coffee made in the Turkish way is a strong stimulant. The coffee is boiled in a little pot of water till a creamy froth comes on the top, then a few drops of cold water are poured in to settle it, and sugar is added in the pot.

Grape skins, being indigestible, stave off hunger; so does "smoking." Where the tobacco is only fit for cigarettes, a supply of papers should be taken.

It is best to filter all "unknown" water. The pocket-filter, with a double length of tube (the longer the better) as a syphon, can be used conveniently in a bucket. The metal-covered filters of the Silicated Carbon Company are smaller, cleaner, and stronger than the plain carbon blocks. An exploring party with ample transport should also take one of their Army medical filters (7 in. × 7 in.), weighing 9 lbs.

The small filters should be constantly washed, boiled, and baked, or they become useless. With very dirty water, the filter may be used in a pocket handkerchief or bit of canvas.

Where troops have been engaged, search the streams for dead animals, and the wells for corpses. At Sedan in 1870, and at Karahassan Keue in 1877, wells were thus polluted and used in ignorance.

Leather or canvas water pack-bags require aprons to protect the animal from the wet.

Books, Stationery, and Instruments.

A Prayer-Book may be wanted to read the Burial Service.

The army field post would provide post-cards, and should supply

[1] Major C. J. East, A.Q.M.G., points out to me that the food tins in the French Army are each furnished with a wire loop so that they can be strapped on to the kit. This addition can easily be made at home.

franked envelopes, to avoid troubling every one with carrying them. At need, a sheet off the pad can be sealed up as a letter.

The map (generally calico) should be ruled in squares, each side a mile, or some sub-multiple of a mile (unless the scale be very small). The lines should be magnetically N. and E., so that, with a compass and a protractor, places that can be seen may be identified.

Graphine, in sheets, is the most portable form of ink—a small piece put into water makes enough to fill a bottle.

A sketching case should have a thoroughly efficient waterproof cover. Tough bank-post paper with blue lines should be taken for sketching. Large notebooks 8 inches by 4½ inches are convenient in wet weather.

Scale (logarithm) paper is invaluable for Officers who have to make sketches of details. Notebooks should be made of this paper.

The shading of ground is much more quickly and easily done with a pencil and stump than in any other way.

The compass should have a small socket that will screw to it. This allows of its being stuck on the top of a stick, so as to be steady. Any rough stick can be cut and used in this way. Elliott, in the Strand, makes these sockets.

A sextant is occasionally useful, as on ship-board, where a compass is thrown out.

Officers, particularly when detached, require to keep copies of reports in order to refer to them again. Van Anden's roller copying-press is the most portable. Copying books (foolscap size) are required as well.

Military attachés and explorers do well to take meteorological observations daily. Casella makes admirable maxima and minima pocket thermometers in ebonite cases for the purpose.

Medicines, &c.

In addition to the graver ailments—such as typhus, typhoid, cholera, and acute dysentery—diarrhœa, dysentery, and low fevers are common. When a doctor is at hand, consult him, but in his absence, should bad diarrhœa begin, avoid meat and bread; use only milk or filtered water; take rice and rice water, and keep warm. A dose of rhubarb sometimes cures it; a good dose of chlorodyne is also an efficient temporary remedy when on the move. Collis Browne's chlorodyne is said to be the best. The doses mentioned on the instructions may be exceeded by a quarter with safety.

English doctors in Turkey found that, at the beginning of dysentery, a dose of castor oil often effected a cure. Ipecacuanha is also useful.

Good quinine (sulphate) becomes scarce in a big war, so a small supply is perhaps worth taking. Learn to judge what, say, 5 grains look like on your hand, and eat them up out of your hand, taking some water to wash the quinine down.

Officers, when likely to be engaged, should take a piece of lint with the calico bandage. A litter can be made with two muskets and a great

coat. The barrels are put into the sleeves, and the skirts may be fastened round the stocks with strong safety pins.

Silk pocket handkerchiefs should be large enough to act as slings for wounded arms.

In the absence of a doctor it is worth while to carry some of each of the remedies marked A and B. Carbolic oil (the acid and olive oil being as 1 to 10) is useful for dressing horses' sore backs, heels, &c.[1] Paraffin ointment is also said to be useful.

Sundries.

A second watch is most useful. Even if the first do not break down, it is often necessary to lend one to servants, &c. The "best" watch, at all events, should have a seconds hand. A repeater is very convenient at night, as it saves striking a light. The same key should do for both watches. A detached party, particularly with native servants, would find a small alarum very useful. The difficulty of starting in time is a daily irritation.

The engineer signalling telescope is an excellent one, In very damp weather it sometimes draws out badly; a little grease prevents this. The caps require a small connecting strap to prevent their pulling off. The best field-glasses are not nearly as efficient, though useful to catch objects.

The soldier's wooden water-bottle, fitted with light leather straps, is about the best there can be: it keeps water cooler than the ebonite bottle. It also forms the best store bottle for brandy in one's baggage. A soft wood plug should be pushed from the inside into the metal mouthpiece, as the ordinary plug is apt to be knocked out when carried in the luggage.

Chesterman's steel metre and yard measure answers for all purposes. It measures the girth of trees, the calibre of guns, &c., and with it a sounding or measuring rod or string can be marked for use. Officers do not want tapes: "pacing" is good enough for war.

A pocket-lamp is frequently required. The twilight is so short in many countries one is constantly caught, and it is often necessary to dismount and hold a light to the ground to find the track. One should be able also to write and read an order on the march. It is best to take regular lamp candles, as they burn longer than others. They should be economised by burning common candles (they can often be got) except out of doors. In camp the lamp candle-holder acts as a separate candlestick. The cylindrical railway lamp, with revolving outer body, is the best, but it wants a cap with a grating for use in the open air. Salsbury makes these.

Brass dish candlesticks that screw together are the most portable. Only the scribes want them.

The knife should have a strong horse-picker, a leather punch, a tin-opener, screw-driver, corkscrew, and small tweezers, and, if gaiters are to be worn, a button hook. The big blade should have a spring stop, a saw blade is a delusion.

[1] The Spanish muleteers believe in a still readier (saline) application for this purpose.

Thick Turkish towels hold most water, and in damp weather can be used undried much longer than others.

Modes of Carrying Equipment A.

For a mounted Officer, and particularly a Staff Officer, it is important that, whatever breaks down, he may be able to go on, as long as he and his horse stick together. The following arrangement is therefore suggested, and bearing in mind that the wallets may remain on the saddle, it is best to put the many small articles into the saddle pockets. Flasks particularly, and occasionally revolvers, have an unaccountable way of getting emptied if out of one's sight. They should be looked to each morning, and so should the water bottle:—

(*Mounted List.*) *Total* 36½ *lbs.*

In saddle cover as valise (9 lbs.).	In two saddle pockets (11½ lbs.).		In or over wallets (14½ lbs.).	In clothes pockets (1 lb.).
Kit-bag.	Etna complete.	Food.	Waterpf. cloak.	Dictionary?
Air-cushion.	Spoon and fork.	Knife (clasp).	Revolver.	Notebook.
Blanket-bag.	Cup.	Comb.	Water-bottle.	Penholder.
1 pair canvas shoes?	Sponge & bag.	Toothbrush.	Food.	Compasses?
1 Basin?	Protractor.	Medicines (A)	Telescope.	Map.
	String (30 ft.).	Writing pad.	Lamp.	Watch.
	Towel.	Calico bandage.	Compass.	Seal and wax.
	Shirt?	Filter?	Pocket-flask.	Pencil.
	Diary?	Pair drawers?	Pair of socks.	Measure.
	Ink bottle.	2 spare candles?	Nightcap.	Keys.
	Soap.			Ink, papers.
				Purse.

The food is that marked A in the general list.

In moving fast it is inconvenient to carry the telescope and compass slung by the straps. A small strap on the compass case to secure it to the belt is most convenient when in uniform. In plain clothes an outside breast-pocket is the best place for the compass case. Officers accompanied by mounted servants can get some of the above carried by them, and also some extra articles such as a bath and a bucket. At a pinch one can tub with the basin or the horse can drink out of it if necessary.

The waterproof cloak is rolled and strapped over the wallets.

If it be likely the revolver will be wanted, it should be strapped in its cover outside the cloak with the near cloak strap. It is then at hand.

The water bottle or telescope may be similarly attached.

In cold weather the regimental coat would be worn.

The blanket (in a roll about 21 inches long) and cushion should be put, at starting, into the kit-bag inside the saddle-cover.

Mounted Officers are comparatively well off; a much more numerous, and therefore more important body, the leaders of the infantry,

LIST OF NECESSARIES AND LUXURIES FO

Those marked **A** to accompany the Officer always. Those marked **B** to do so when convenient. Those mark

Luggage and Furniture.

No. and Description.	How carried.	Approx. weight.	Approx. cost.
		lbs. oz.	£ s. d.
Soldier's kit bag	A	1 9	0 4 9
Bedstead bag ..... ?	B (1)	2 0	0 15 0
Mule basket, 24 in. by 11 in. by 15 in. deep inside	B (2)	16 0	2 5 0
or			
Bed bag	B (1)	12 0	2 15 0
Furniture.			
1 Air cushion	A	3 0	1 5 0
1 Blanket bag	A	4 8	1 5 0
1 Bath and case	A or B	2 8	0 17 0
1 India-rubber basin	A or B	0 12	0 5 6
1 4-legged stool (Field's)	B (2)	2 0	0 7 6
1 Table complete ..... ?	B or C (1)	6 0	0 14 0
1 Pole strap ..... ?	B	0 10	0 2 9
1 Looking glass ..... ?	B (1)	0 8	0 0 6
1 Sword cover, leather ?	B or C	0 8	
1 Spare blanket ..... ?	B	4 8	0 8 6
1 Folding chain chair... ?	C (1)	5 0	0 15 6
1 Ground sheet ..... ?	?	3 7	0 15 0
1 Bedstead..... ?	B or C	14 0	1 10 0
or			
Gwynfe hammock ..... ?	B or C (15)	12 0	2 10 0
Tent for ditto ..... ?	B or C	5 0	0 10 0
or			
Regulation bed valise... ?	B or C	9 0	1 6 0
		Totals. lbs. oz.	
In addition to luggage	A	9 1	
	B	11 4	
	C	0 0	
	?	36 9	

Clothes.

No. and Description.	How carried.	Approx. weight.	Approx. cost.
		lbs. oz.	£ s. d.
Regulation waterproof cloak and hood	A	3 12	2 8 6
1 Pair riding boots...	A	4 0	1 16 0
1 Pair india-rubber ,, ...	B	5 0	1 8 0
1 Pair shooting boots ...	C	3 2	1 7 6
4 Spare laces ..... ?	A & B	0 1	0 2 0
1 Woollen night cap	A	0 2	0 1 10
1 Pair leather gaiters ?	A B or C	1 0	0 6 3
3 Flannel shirts	1 of each A rest B	2 4	1 10 0
3 Pairs drawers		1 4	0 16 6
3 Silk handkerchiefs...		0 3	0 9 0
3 Pairs of wrstd. socks		1 4	0 11 0
2 Pairs stockings	B or C	1 2	0 8 0
2 Cholera belts	A & B	0 10	0 9 0
1 Face net bag ..... ?	A or B	0 0	
1 Spare pair braces	B	0 2	0 3 6
1 Pair sleeping trousers	B	1 0	0 8 9
1 Pair canvas shoes	A (6)	1 0	0 2 6
1 Fur cap..... ?	B or C	0 6	
1 Cashmere neck handkerchief..... ?	A	0 3	0 2 10
2 Pair woollen drawers ?	A	2 0	0 14 0
2 do. vests ... ?	A	1 8	0 13 0
Uniform.			
1 Helmet	A		?
1 Forage cap	A or C		?
1 Sword	A	3 8	
1 Sword sling	A	0 1	0 3 0
1 Sword belt	A		?
1 Cross belt.....	A or C		?
2 Patrol jackets	A & B	6 0	9 0 0
2 Pair pantaloons	A & B	3 0	
1 Cloth great coat.....	A or C	7 8	5 5 0
1 ,, cape..... ?	A or C		
3 Pairs white woollen gloves.....	A & B	0 9	0 6 0
1 Pair bearskin gloves ?	A or C	0 6	0 5 0
1 Tunic..... ?	A or C	3 2	
Evening dress clothes, &c., for travellers ... ?			
		Totals. lbs. oz.	
Ex. Waterproof.....	A	4 5	
	B	16 2	
	C	1 6	
	?	11 0	

Cooking Materials and Food.

No. and Description.	How carried.	Approx. weight.	Approx. cost.
		lbs. oz.	£ s. d.
1 Etna, consisting of—			
1 Tin and lid			
1 Burner and stand ...			
1 ½-pint spirit bottle ...	A		
1 Match box	(4)	2 6	0 4 0
1 Strainer (net)			
1 Strap			
1 Spoon and fork	A	0 2	0 3 0
2 Pint tins of spirit	B & C (1)	2 5	0 6 0
1 Canteen case, containing—			2 0 0
1 Tin kettle.....			
1 Frying pan			
1 Wire gridiron			
1 Crk. screw (Shafer's)			(0 1 3)
1 Salt and pepper box	B for 3	15 0	(0 1 9)
1 Tin opener (Lund's)			
1 Small meat knife ...			
1 Cook's iron fork and spoon			
1 Small soup ladle.....			
2 Plates			
2 Tin cups			
2 Spoons			
2 Small spoons	B	2 0	
2 Knives			
2 Forks			
1 Egg cup			
Food.			
Compressed tea	A (13)	0 2	
,, ...	B	0 8	
,, or	C	2 0	0 6 0
Tea, milk and sugar in 3 oz. tins	A (7)	0 3	
	B	1 2	
Coffee and milk in ¼-lb. tins	A	0 8	0 0 6
	B	3 0	0 3 0
,, ,,	C	4 0	0 4 0
Cocoa and milk ,,	B	1 8	0 1 6
,, ,, ...	C	4 8	0 4 6
Cooked corned beef in 2-lb. tins	A	0 8	0 0 7
	B	4 0	0 2 8
,, ,,	C	6 0	0 4 0
Brand's extract of meat	A	0 1	0 2 3
	B	0 4	
Consolidated pea soup	A	0 3	0 0 1½
,, ,,	B (7)	2 0	0 1 6
,, ,,	C	2 0	0 1 6
Ship's biscuit	A	1 0	0 9 0
,, ,, ...	B	?	
Salt, pepper, and sugar	A	0 2	
,, ,, ,,	B	?	
		Totals. lbs. oz.	
Inc. 2 lbs. 11 oz. of food	A	5 4	
Inc. 12 lbs. 6 oz. of food and 7 lbs. for canteen	B	20 8	
Inc. 18 lbs. 8 oz. of food.	C	19 11	
	?	0 0	

Stationery and Med

No. and Description.	How carrie
1 Purse.....	A
1 Pocket dictionary	A (5)
1 Protractor	A
1 Penholder	B
1 Note book 5½ in. by 3½	A
2 ,, ,, ,,	B
1 Pocket diary	A
1 Map of country	A
1 Small writing pad	A
Seal and wax	A
1 Ransome's ink bottle...	A
1 Packet ink papers	A & B(1
1 Soldier's pocket book	B
Writing and blot. paper ?	B
Envelopes and pens ... ?	B
Extra for Staff and R.E.	
1 Pair folding compasses	A
Sketching case and cover, or sabretache...	A or
1 Aneroid (3 in.)	A
Ruled post paper	A
India-rubber pencil	A
Coloured & common ,,	A
Shading stump [large]...	A
2½ Inch colour box, 1½ oz.	B
Scale paper	B
1 Tin desk filled, and canvas cover.....	B or C
Abney level.....	A or C
Sextant..... ?	B
1 Roller copying press ...	B (9)
1 Bottle copying ink ... ?	B
Copying books	B
Paper, &c.	B
Medicine.	
8 5-grs. silvered pills of quinine	A
Half-oz. bottle of sulphate of quinine	B
2 Small bottles of chlorodyne	A & B
1 Tin mustard leaves ...	A or B
1 Small bottle of rhubarb	A or B
Sticking plaster, lint, bandage, needles & thread, safety pins ...	A
20 5-grs. pills of ipecacuanha	A & B
Insect powder..... ?	A
Carbolic oil or paraffin ointment ..... ?	A & B
Snake medicine.	
Exclusive of those for Staff and R.E.	A
	B
	C
	?

URIES FOR CAMPAIGNING AND EXPLORING.

. Those marked **C** as a reserve or when in a standing camp near the base. Those marked **?** are exceptional.

TIONERY AND MEDICINES, &c.				SUNDRIES.				HORSE APPOINTMENTS.				REMARKS.
scription.	How carried.	Approx. weight.	Approx. cost.	No. and Description.	How carried.	Approx. weight.	Approx. cost.	No. and Description.	How carried.	Approx. weight.	Approx. cost.	
		lbs. oz.	£ s. d.			lbs. oz.	£ s. d.			lbs. oz.	£ s. d.	
.....	A			2 Watches and keys	A	0 12		1 Pair reg. spurs	A	0 12	0 10 0	Almost everything in this list can be procured from the Army and Navy Stores, 117, Victoria Street, where arrangements are being made to keep a sample set. A few additional references are given.
onary	A (5)	0 3½		2 Spare do. keys	A			2 Spare straps for ditto	A	0 1	0 0 6	
.....	A	0 1	0 2 6	1 Telescope	A	2 0	2 5 0	1 Regulation saddle, with thong, girth, stirrups & shoe case	A			
.....	B	0 0½	0 0 6	1 Prismatic compass.....	A	0 9	2 4 0					
½ in. by 3½	A	0 4	0 1 0	1 Water bottle 1½ pints, with straps [filled] ...	A (14)	2 10	0 3 6	2 Wallets	A	17 8	5 16 6	
y	B	0 8	0 2 0					2 Pockets.....	A	2 0	1 12 6	
ntry	A	0 8	0 1 0	1 Pocket flask ,, ...	A	0 8	0 4 6	3 Cloak straps	A	2 0	1 12 6	(1.) White, Aldershot, where also samples can be seen.
ng pad	A	0 2		1 Steel yard measure ...	A	0 1	0 2 0	3 Valise straps	A	0 8	0 3 0	(2.) Allen, the Strand.
.....	A	0 2		1 Pocket lamp	A (3)	0 10	0 7 0	1 Saddle cover	A	1 0	0 3 6	(3.) Salsbury, 126, Long Acre.
nk bottle...	A	0 4	0 4 0	1 Collapsing cup	A	0 4	0 3 6	1 Spare shoe and nails ...	A	2 0	0 5 6	(4.) Scott, 42, Bedford Street.
papers	A&B(10)	0 1	0 0 6	1 Comb in case	A	0 1	0 0 9	1 Double bridle and bits	A	1 4		(5.) Intelligence Branch, War Office.
ocket book	B	1 0	0 3 5	1 Havresack, linen	A	0 9	0 0 9	1 Headstall and halter...	A	5 0	1 2 0	(6.) The North British Rubber Company, 4, Cannon Street.
blot. paper ?	B	1 8		1 ,, mail cloth?	A	1 2	0 8 6	1 Reg. nosebag	A	2 4	0 7 3	
l pens ...?	B	0 8		1 Knife (clasp)	A	0 8		1 Horse blanket	A	1 3	0 5 6	(7.) Kopf & Co., 6, Adam Street, Adelphi.
				1 Revolver and case	A	2 0	2 0 0	1 Roller	A	7 0	0 13 6	(8.) Barron & Wilson, Strand.
STAFF				Cartridges for do. (0·455 inch)	A & B	0 8		1 Reg. packsaddle complete with surcingle and tarpaulin		1 0	0 4 6	(9.) Mordan, 72, Cheapside, E.C.
R.E.				1 Small towel	A	0 10						(10.) Marcus Ward's Graphine.
compasses	A	0 1	0 13 6	1 Piece soap	A	0 1						(11.) Lund, 24, Fleet Street, E.C.
case and				1 Tooth brush and cap...	A	0 2	0 0 9	1 Headstall and halter	A or B	57 0	4 15 0	(12.) Silicated Carbon Filter Co., Church Road, Battersea.
abretache...	A or B			1 Pair boot hooks ..... ?	A	0 4	0 1 10	1 Blanket.....				
in.)	A	0 10		1 Pocket filter (12) 2½in. by 1½in.	A or B	0 8	0 5 0	1 Nosebag				(13.) Goundry, 181, Upper Thames Street.
aper	A							1 Spare shoe and nails				(14.) Ascher, 28, Maiden Lane.
pencil	A		0 0 6	Spare tube & plug for do.	A	0 0½	0 0 4	1 Spare halter.....	B	0 8	0 1 5	(15.) Silver, 66, Cornhill.
	A			2 Towels	B	2 8		2 Roller bandages	B	0 8	0 2 3	
ommon ,,	A			1 Pair candlesticks 3in. ?	B (8)	0 6	0 2 6	1 Curry comb (for 3) ...	B	0 8	0 0 7	
p [large]...	B	10 0		2 Spare cloak straps	B	0 3	0 1 4	2 Brushes (for 3)	B	1 8	0 8 0	
box, 1¼ oz.	B		0 7 0	1 Large tin of wax matches	B	0 4	0 1 0	1 Spare fore shoe	B	1 4		
								1 ,, hind	B	1 4		
filled, and								Spare nails	B	0 2		
ver.....	B or C		1 15 0	1 Ball of string	B	0 2	0 0 4	1 Pair hunting spurs... ?	B	0 8	0 12 6	
.....	A or C	0 9	1 13 0	4 Small gimlets for pegs	B	0 4	0 1 0					
..... ?	B	1 0	3 15 0	1 Housewife complete ...	B	0 4	0 5 6					
ing press ...	B (9)	1 0	0 8 0	1 Holdall, with scissors, hair, tooth, clothes, and nail brushes, and soap box	A or B	1 2	0 8 6	**FOR CAMP.**				
ng ink ... ?	B	0 5	0 3 0					1 Canvas bucket	A or B	1 0	0 2 0	
s	B	0 2	0 1 0					1 Picket shovel ..... ?	(1)	2 8	0 2 6	Steel articles, such as scabbards, spurs, chains, &c., can be plated with nickel at small cost at the A. & N. Stores: this prevents rust.
.....	B	?	?					1 Hand axe ..... ?		2 0	0 2 6	
				Case for 2 candles	A or B	0 2	0 0 4	1 Shoeing hammer... ?		1 0		
				1 Small sponge and bag	A	0 6	0 1 10	1 Picket rope ..... ?		8 8	0 2 6	
				4 Spare tooth brushes ...	B	0 3	0 1 8	1 Heel rope		1 10		
				2 ,, nail brushes.....	B & C	0 2	0 1 0					
INE.				3 Shoe brushes (for 3) ...	B	1 8	0 3 9					
red pills of				1 Water bottle for reserve of brandy	B	2 10	0 1 2	2 Canvas water bags for carrying water on a horse; each for 8 gallons (per party) ..... ?	B or C			Where articles are marked to two letters with "or," their weight is assigned to the second letter.
.....	A		0 2 0									
tle of sul-												
uinine	B		0 7 6									
es of chlo-				Soap	B & C	1 8	0 0 9					
.....	A & B		0 1 7	Lamp candles, 12 to a lb., in a tin	B	2 0	0 2 0					
d leaves ...	A or B	1 8	0 1 1		C	3 0	0 3 0			5 0		
of rhubarb	A or B		0 0 7	Useful papers	A, B, C	1 8	0 0 8	1 Mallet..... ?		1 0		The totals given below do not include clothes actually worn (though the numbers in the lists include those worn), nor arms, telescope, compass, and watch, which are also worn.
ster, lint,				6 India-rubber bands ...	B	0 2	0 0 3	1 File ..... ?		0 2		
needles &				6 Split steel rings	B		0 0 2					
fety pins ...	A		?	4 Tins of dubbing	B & C	0 8	0 1 2					
pills of				1 Spare lamp glass	B	0 2	0 0 6					
ha	A & B		0 0 8	Prayer book	A							
r..... ?	A	0 4	0 0 9	Passports..... ?	A							
or paraffin				Pocket alarum ..... ?	B or C	0 4	1 0 0					
..... ?	A & B	0 6		Tobacco	A & B							
ne.												
		Totals. lbs. oz.				Totals. lbs. oz.				Totals. lbs. oz.		GENERAL TOTAL = 191lbs. exc. of horse appts.
those for R.E.	A	2 2			A	6 6		All for horse	A	44 0		A = 71 lbs. (Including 44 lbs. for horse appts.)
	B	4 15			B	12 10			B	7 6		B = 73 lbs. (Including 13 lbs. of food, 7½ lbs. for horse, and 7 lbs. for canteen.
	C	0 0			C	5 2		Exclusive of pack equipage	C	1 10		C = 28 lbs. (Including 18 lbs. 8 oz. of food and 3 lbs. of candles.
	?	0 7			?	2 12			?	20 2		? = 71 lbs. (Including 11 lbs. of camp equipment.)

T. FRASER,
Captain R.E. and Major.
February, 1879.

A.

(About 27 lbs., exclusive of things worn on person.)

Luggage and Furniture.

1 Soldier's kit bag.
1 Air cushion.
1 Blanket bag.

Clothes.

Regulation waterproof, complete, or Regimental great coat, do.
1 Pair boots.
1 Woollen nightcap.
1 or 2 Flannel shirts.
1 or 2 Pairs drawers.
1 or 2 Silk handkerchiefs.
2 Pairs socks.
1 Cholera belt.
1 Pair canvas shoes.
1 Helmet.
1 Sword.
1 Sword sling.
1 do. belt.
1 Patrol jacket.
1 Pair pantaloons or trousers.
1 Pair white woollen gloves.

Cooking and Food.

1 Etna, complete.
1 Spoon and fork.
Compressed tea or coffee, and milk.
Preserved meat.
Pea soup.
Biscuit.
Salt, pepper, sugar.
Water bottle, filled.

Stationery.

1 Purse.
1 Pocket dictionary.
1 Protractor.
1 Penholder.
1 Note book.
1 Pocket diary.
1 Map.
1 Writing pad.
1 Seal and wax.
1 Ransome's ink-bottle.

Extra for Staff and R.E.

1 Pair folding compasses.
1 Sketching case and cover, or sabre-tache.
1 Aneroid.
Bank-post paper.
Pencils.
Shading stump.

Medicines.

Quinine.
Chlorodyne.
Sticking plaster.
Lint bandage.
Needles, thread.
Safety pins.
Ipecacuanha.

Sundries.

2 Watches and keys.
2 Spare keys.
1 Telescope.
1 Prismatic compass.
1 Water-bottle.
1 Pocket flask.
1 Steel yard measure.
1 Pocket lamp.
1 Cup.
1 Comb.
1 Sponge and bag.
1 Havresack, linen.
1 Clasp knife.
1 Revolver (and case) loaded.
5 Spare cartridges.
1 Small towel.
1 Piece of soap.
1 Tooth-brush and cap.
1 Case and 2 candles.
Useful papers.
Matches.
Tobacco.

Note.—The numbers in A include clothes worn.

B.

(About 65 lbs., exclusive of lug

Luggage and Furniture.

Mule baskets or bed bags.
1 Four-legged stool.
1 India-rubber basin.
1 Do. bath.
1 Sword cover.

Clothes.

1 Pair boots.
2 or 1 Flannel shirts.
2 or 1 Pair drawers.
2 or 3 Silk handkerchiefs.
3 Pairs socks.
1 Pair stockings.
1 Cholera belt.
1 Spare pair braces.
1 Pair sleeping trousers.
1 Patrol jacket.
1 Pair pantaloons or trousers.
2 Pairs white woollen gloves.

Cooking and Food.

1 Pint tin of spirit.
Canteen, complete (1 for 3).
Compressed tea and tea and milk.
Coffee and milk, or cocoa and milk.
Preserved meat.
Brand's extract.
Pea soup.
Biscuit.
Salt, pepper, sugar.

Stationery.

1 Penholder and pens.
2 Note-books.
1 Packet ink papers.
1 Soldier's pocket-book.

Colo
Scale
1 Ro
1 Bo
Copy
Pape

Quir
Chlo
Mus
Rhu
Ipec

20 R
2 To
2 Sp
1 Ti
1 Ba
4 Sm
1 Ho
1 Ho
2 Sp
1 Sp
3 Sh
1 W
Soap
Lam
Usef
Indi
Split
1 Tir
1 Sp
Toba

RRANGED UNDER THE HEADS **A, B, C,** AND **P.**

B.
exclusive of luggage and extras.)

Extra for Staff and R.E.

Colour box (2½ in.).
Scale paper.
1 Roller copying-press.
1 Bottle copying ink.
Copying books.
Paper, &c.

Medicines.

Quinine.
Chlorodyne.
Mustard leaves.
Rhubarb.
Ipecacuanha.

Sundries.

20 Revolver cartridges.
2 Towels.
2 Spare cloak straps.
1 Tin of matches.
1 Ball string.
4 Small gimlets.
1 Housewife.
1 Holdall.
2 Spare tooth-brushes.
1 Spare nail-brush.
3 Shoe-brushes (for 3).
1 Water-bottle (brandy).
Soap.
Lamp candles.
Useful papers.
India-rubber bands.
Split rings.
1 Tin dubbing.
1 Spare lamp glass.
Tobacco.

C.
(About 28 lbs.)

Clothes.

1 Pair boots.
1 Pair stockings.
1 Forage cap.
2 Pairs socks.

Cooking and Food.

1 Pint tin of spirits of wine.
Compressed tea.
Coffee and milk.
Cocoa and milk.
Cooked corned beef
Brand's extract.
Consolidated pea soup.
Ship's biscuit.
Salt, pepper, and sugar.

Stationery and Medicine.

Extra for Staff and R.E.

Tin desk.

Sundries.

2 Spare tooth-brushes.
1 Do. nail-brush.
Soap.
Lamp candles.
Useful papers.
3 Tins dubbing.

P
(About 60 lbs.)

Furniture.

1 Bedstead bag.
1 Looking-glass.
1 Table.
1 Pole strap.
1 Bedstead, or
1 Valise.
1 Spare blanket.
1 Folding chair.
1 Ground sheet.
1 Bedstead bag.

Clothes.

4 Spare laces.
1 Pair leather gaiters.
1 Face net bag.
1 Pair hunting spurs.
1 Fur cap.
1 Cashmere handkerchief.
2 Pairs woollen drawers.
2 Woollen vests.
1 Cross belt.
1 Pair bearskin gloves.
1 Tunic.

Stationery.

Abney level.
Sextant.
Writing and blotting paper.
Envelopes and pens.

Medicines.

Carbolic oil, or
Paraffin ointment.

Sundries.

1 Havresack (mail cloth) for infantry.
1 Pair boot hooks.
1 Pocket filter.
Spare tube and plug for do.
1 Pair candlesticks.
Passports.
Alarum.

and Camp Equipage, see the General Table.

are much less so, and the arrangement of their kit requires even greater care.

In a battalion the three Officers in each company might arrange equipment A somewhat as follows, viz.:—

(*Dismounted List.*)

In kit-bag. For each (19 lbs.).	In mailcloth and linen havresacks (5 lbs.).		Separately. Each (11½ lbs.).
	Each (3 lbs. 3 ozs.).	Among 3 (5 lbs.).	
Blanket-bag.	Food.	1 Etna, complete.	Revolver.
Air-cushion.	Pocket flask.	1 Lamp.	Telescope.
Food (reserve).	Knife (clasp).	1 Compass.	Waterproof cloak.
Towel.	Fork.	1 Protractor.	Waterbottle.
Shirt.	Spoon.	1 Writing-pad.	
Pair drawers.	Cup.	1 Chlorodyne.	Dictionary?
Comb & toothbrush.	Nightcap.	1 Tin coffee (½ lb.).	Notebook.
Sponge and bag.	Pair of socks.	2 Pea soup (6 ozs.).	Penholder.
Tin of dubbing.	3 bootlaces.	1 Filter?	Map.
2 spare candles.	Calico bandage.	Ink bottle.	Watch.
Etnas (2 for 3).	Cloak strap.		Pencil.
Pair of canvas shoes.			Measure.
Filter (2 for 3)?			Keys.
Bath (1 for 3).			Seal and wax.
Bucket (1 for 3).			Purse.
Soap and case (1 for 3).			Ink, paper.

Each Officer would thus have to carry 16½ lbs., including food and water, or rolls including sword. A mailcloth havresack with a broad web strap is most convenient.

The baggage in the kit-bag for 27 dismounted Officers would weigh 513 lbs. This could be carried by 3 pack-horses, as the movements of infantry are, of necessity, slow: 4 would, however, be better, 2 to each half battalion. These could accompany the battalion even when the transport for the canteens and for the balance of the baggage could not keep up with the troops. The articles should be put in the blanket-bags, or they may fall out; and the kit-bags should be secured, *necks up*, in case of a ford. Officers would, of course, gladly provide themselves with a pack-horse a-piece, in order to have more comforts, but this would add 27 pack-horses to the large number which it is anticipated must of necessity be used in future to carry ammunition and water, and perhaps intrenching tools.

Owing to the difficulty of feeding so many animals and to the space they would occupy on the march this could not be permitted. The heavier baggage must, therefore, when carried at all, be carried on wheels, which are more economical of transport and of road-space. In moving in clear country as a rule the battalions would march *off* the roads, whenever time pressed, so as to leave the roads free for

carriages. In such case wheeled battalion transport would have to separate from the men and fall into the general train; while the pack animals would invariably accompany their own battalion. It will be noticed that by this arrangement the 9 canteens for 27 Officers are to come up in the baggage waggons. If on pack-saddles, an additional pack-horse per battalion would be required. Each pack-horse should have a light tarpaulin cover for baggage.

When transport permits, the Officers' bed-valises would come up with the baggage waggons, and can then be used with the air-cushions. The air-cushion also does as pillow and mattress with a camp bedstead, or a hammock.

Travellers should make arrangements with agents for the transmission of their letters. Most people find that weekly newspapers, such as *Public Opinion*, the weekly edition of the *Times*, and the *Pall Mall Budget*, are the best to have sent out. A great mass of daily papers sent out to the army clogs the field posts, and the very transport of them is a difficulty; a few papers go a long way in the busy times of movement; as fuel they are sometimes useful.

Officers or others who may have important duties should never, in personal matters, do for themselves what they can get their servants or others to do equally well for them. They should save all their energies for their own work, and for the same reason should, while taking cheerfully what is unavoidable, avoid all unnecessary exposure and discomfort. Chills, and having to remain long in wet clothes, are the chief causes of illness apart from bad water and food. When in tents or huts, a special precaution should be taken against having to turn out at night.

Officers and others should always look as carefully after their servants' kit as after their own, and should see that they are provided in a way to carry them through the extra exposure they may have to face, both as regards clothes, bedding, and food. They seldom think of this themselves.

A servant wants a waterproof, a watch, and a blanket-bag; a squad bag takes his extra kit.

Gentlemen: My task to-night has not been without pain; because each recollection it brings back, reminds me of the comrade[1] we have buried to-day. One, whose soldier-like spirit and brilliant memory, rich in recollections of the fighting lore of our Army, so often, when we were together, drove discomfort out of mind, and banished weariness from many a weary march.

The CHAIRMAN: I think, gentlemen, before the evening closes we should give our best thanks to Major Fraser for the very interesting and suggestive paper which he has read to us. I have had considerable experience in this matter of baggage, as I turned my particular attention to it before I went on service in the Crimea, and made it a study whilst I was at Scutari preparing for service. I purchased a good Turkish pony and set to work to organize my baggage, and I arrived at something very much like the model you see before you. I had taken out with me one of

[1] The late Colonel Home, R.E.

Peats' pack-saddles, and I had two bullock trunks of simple construction. I had a camp bedstead very much like Mr. White's camp bedstead; but then there were few made, and it was made of iron instead of wood, consequently it was much heavier than what is now made; it had a very thin mattress to it. At Constantinople I had made a thin table very much like a portfolio that fitted into the top of one of the bullock trunks, and at the top of the other a simple camp stool. The table had a trestle which fitted over the saddle lying on the two bullock trunks. The bed went along the centre. There were two horn-like projections sticking up in front and behind the pack saddle, the bed lying between them. I was allowed a tent, and this tent was folded loose and put into a bag with half the pegs at each end; this bag was put crossways over the two bullock trunks and the bed, with a surcingle over the whole, and my baggage was complete. But to bring it down to the dimensions that could be carried by a pack animal, a pony, required a considerable deal of study; article after article was cast off. I even had to look at a nice pair of socks, and though I regretted them very much they had to go,—down even to so small a thing as that had I to calculate to get the weight down to what was required. I had a small simple camp kettle, that went in one bullock trunk, and I carried a little tea, coffee, sugar, and rice with me, and it altogether, with the tent, came to 220 lbs. My pony was a capital strong grey pony, which I brought to England afterwards. I had that baggage the whole time I was in the Crimea. I took it up to Shumla, and all round the south of the Crimea, on an excursion, when we frequently had to go at a very sharp trot, and it never moved, never broke down, and I never had an accident with it the whole time I was there. Therefore, gentlemen, I think I can speak very favourably of that sort of baggage, but it requires care and organization. I saw the baggage of our division starting the first day we left Varna, and before we got the baggage train under weigh, every young Officer's kit was kicked off all over the place simply from want of care and good organization. Forethought and arrangement is what is wanted more than anything; you should carefully choose your baggage, then organize it completely, and have every article calculated to an ounce before you go on service, and it repays you cent. per cent. in the comfort you derive from it afterwards. There is no subject that requires more study, more care, than that of carrying your baggage when on service, and it adds to your comfort more than anything else. I am sure we must thank Major Fraser for having done his best to add to the means that Officers have of studying the subject, and of making up their minds as to what they are likely to want beforehand.

LECTURE.

Friday, February 28, 1879.

ADMIRAL SIR COOPER KEY, K.C.B., F.R.S., in the Chair.

THE HERALDRY OF THE SEA:—ENSIGNS, COLOURS, AND FLAGS.

By J. K. LAUGHTON, M.A., R.N., Lecturer on Naval History at the Royal Naval College.

AN examination into the origin and history of the several flags now worn by the navies of the civilized world, as emblems or marks of their nationality, of their allegiance, or, to some extent, of their organization, may perhaps seem but a piece of antiquarian trifling. The main interest of it is undoubtedly due to that feeling which leads the educated mind to inquire into the usages of the past: but behind the screen of heraldic ornament there is a curious structure of solid history. As I go on, I shall have to suggest to you a consideration of the growth of kingdoms, of the changes and revolutions in their government, of the discipline and organization of fleets, and of the whole art of war by sea, as practised in past ages. It is only in the hope of doing this that I have ventured to bring the subject before an Institution such as this; I may add that it is only as elucidating the graver problems of history that I myself have studied it.

In their earliest use at sea, flags appear to have been merely signals, or rather the means of emphasizing signals. A bit of cloth on the end of a staff, waved up or down, right or left, could be seen from a distance, and give effect to some simple telegraphic code. Difference of colour was afterwards called in to assist; amongst the later Greeks a red flag is said to have been the signal for battle; but the emblem of nationality or party was, till a comparatively late period, a carved image or ornament in wood or metal, partaking thus rather of the nature of a figure-head than of a flag. Thus the Samian ships are described as marked by the figure of the wild boar, which the

Eginetans, on defeating them, sawed off and deposited in their temple of Minerva[1]; and the Latin word *rostra*, which has passed down into modern languages, reminds us that the Romans, in the same way, carried off the beaks—or figure-heads—of captured ships as the trophy of war. On shore, the usage was similar. The standard of the Roman legions was, as is well known, the solid figure of an eagle; it was not till the time of the Empire that flags began to accompany the eagle, and gradually, as being better seen from a distance, to supersede it. But at that time, when the whole known world was Roman, the art of naval war died out; and any flags carried by ships then, or for long after, were probably as mere ornaments, emblems of religion or superstition, of personal vanity or party triumph.

In their modern accepted use, the origin of flags comes out of the dark ages following the break-up of the Empire. How or when, it is impossible to determine. The gaudy colours caught the fancy of the rude tribes from the north, and with a force till then unknown, gradually shaped themselves into alike the pomp of war or the pageantry of civil life. They were adopted by kings and leaders as personal distinctions, and were worn by them or their following both as liveries and flags. It was long, however, before the use hardened down into anything more than this. In our earlier glimpses of military organization, every chieftain or knight, whether serving in the field or on board a ship, had his own distinguishing flag, which, as cognizances were reduced to order and restricted by the laws of heraldry, was of the same colour, and bore the same device as his surcoat or his shield. If several knights were embarked in one ship, that ship carried the flags of all—emblems of individual presence rather than of nationality; and though when engaged in any active service, she would seem to have carried also the flag of the leader or Admiral, her own particular flag bore the emblem of her patron saint, depending thus on the caprice, or piety, or superstition of her owner. In addition to these, she wore the flag of her port—a usage which, as far as merchant ships are concerned, still holds among us in the form of what are known as "house flags," though now, and for centuries past, strictly subordinated to that of carrying the national ensign. With ships of other countries the usage continued till comparatively lately. In France, down to the outbreak of the Revolution, merchant ships flew the flag of their port more commonly than the flag of France; as, for instance, of Marseilles, white with a blue cross; or of Dunkirk, barry of six, white and blue, with the alternative of the old English white ensign—white, with a small St. George's cross in the upper corner near the hoist—derived, of course, from the English sovereignty in the 17th century, and keeping alive the memory of English prowess—should I not rather say the infamy of an English King?

In the Baltic, in the same way, almost every port had its own flag; so also in the Netherlands; and the Free Towns of Germany flew each its own independent flag till within these last few years. In England, a more settled rule had enforced a unity of flag long before;

[1] Herodotus, iii, 59.

but in very early times, in England as in France or elsewhere, a sailor was more distinctly a sailor of his port than of his country; and between different ports, whether of different countries or not, there might be, and not unfrequently was, a state of war: the Cinque Ports might be at war with Normandy, whether there was war between the Kings of England and France or not; and a very bloody war between the Cinque Ports and Yarmouth is a prominent feature in the naval annals of the closing decade of the 13th century.[1] There can be little doubt that, during such partizan wars, the ships carried the flags of their respective ports, and of their knightly leaders.

The earliest form of national flag, however short-lived it might be, was undoubtedly the cognizance of the chieftain or king. Of this nature was the terrible White Horse of the Saxons, or the Raven of the Danes; and, later on, the device of the lions or leopards, assumed by the Norman kings of England; in the first instance, by William Rufus, though in the form in which it has come down to us, by Richard Cœur de Lion. From the end of the twelfth century the three gold lions on a red field, such as we all know them, have been the distinctive badge of England's King, the emblem of England's sovereignty, and of England's power.

It is matter of familiar history that Edward III, on laying claim to the French crown, quartered the French lilies with the English lions; and that from some affectation, which we may wonder at, but cannot interpret, he placed the lilies in the first or honourable quarter, where they remained through many succeeding reigns. That the lions were thus put, heraldically, in a secondary place, is quite certain; but you will remember the elegant way in which Macaulay has interpreted the position:—

> "Look how the Lion of the sea lifts up his ancient crown,
> "And underneath his deadly paw treads the gay lilies down.
> "So stalked he when he turned to flight, on that famed Picard field,
> "Bohemia's plume, and Genoa's bow, and Cæsar's eagle shield;
> "So glared he when, at Agincourt, in wrath he turned to bay,
> "And crushed and torn beneath his claws the princely hunters lay."

I am not now going to follow the royal arms and the royal standard through the many changes they have undergone during these five centuries: to do so would be to give you a genealogical history of England. It is enough to remind you that though different kings or queens have quartered or impaled the arms of their wives or husbands, these have always been considered as accidents, and have not been passed on to their successor. The arms of Scotland and of Ireland, which were quartered with those of England on the accession of James I, have been on a different footing, and considered as integral parts of the royal shield. In a somewhat similar manner the arms of Hanover were introduced by George I, and worn by our kings until, on the death of William IV, the two crowns were again separated. The present standard is thus purely that of the United Kingdom of England, Scotland, and Ireland, without reference to the many quar-

[1] Nicolas's "History of the Royal Navy," vol. i, pp. 267 *et seq.* 280.

terings and achievements to which, by foreign marriages, the reigning Sovereign is heraldically entitled.

By these arms the standard, as now worn by our ships, is completely covered; but formerly it used, sometimes at least, to bear the escutcheon with the crown and the royal supporters on a large field, the colour of which seems to have been quite indeterminate. The standard of William III and Mary bore the arms of the two, impaled, crowned, and supported by the lion and unicorn on a white field, having above, the motto, "FOR THE PROTESTANT RELIGION AND THE LIBERTY OF ENG-"LAND;" and below, "JE MAINTIENDRAY." I have seen a contemporary picture[1] of the standard of Queen Elizabeth, showing the arms, without supporters, but encircled by the motto, on a horizontally striped red and white field; but the picture of the "Great Harry" in the Painted Hall, said to be a copy of one by Holbein, represents the standards as completely covered by the royal arms in their simplest form, not impaling or quartering the arms of any of King Henry's numerous wives, but showing only the lilies and lions.

Of the royal supporters it is not necessary to say much. Before the accession of the Stuarts they were changed at the caprice of the Sovereign, and almost every King or Queen adopted new ones. From these, and from the royal badges, came many of the curious names which may be found in old lists of ships:[2] such as the "Antelope," which refers to one of the supporters of Henry VI; the "Bull," of Edward IV; the "Dragon," of Henry VIII; and, again, of Queen Elizabeth. So also for the badges: the "Sun," "Rose in the Sun," "Falcon in the Fetterlock," were all worn by Edward IV; the "Double Rose" speaks for itself; and the "Hawthorn" belonged to Henry VIII.

Two unicorns had been for several generations the supporters of the royal arms of Scotland; one of these, James I not unnaturally combined with a leopard-faced lion, the representative of England; and the Lion and the Unicorn have been continued ever since as the supporters of the royal arms of the United Kingdom.

So much, then, for the standard, which, though pre-eminent above all flags afloat or ashore, is not peculiarly naval. I pass on to speak of the flag which, alike to friends or foes, betokens an English ship of war.

It is impossible now to determine when the white flag with the red cross—St. George's flag—came to be accepted as the distinctive flag of England. That the cross, as a military emblem, first came into common use during the early Crusades, has been so generally accepted, that I feel some diffidence in remarking that a companion of William, Duke of Normandy, is shown in the Bayeux tapestry as bearing on his lance a pennon charged with a red cross; and the ship in which William sails bears at the main a flag with a blue border and a cross of gold. Certainly, however, it was not till much later that the red cross was considered as peculiarly English, the white cross as peculiarly French. To some extent they were so considered in the time of

[1] In Luke Waghenaer's "Mariner's Mirrour;" 1588.

[2] See Derrick's "Memoirs of the Royal Navy," p. 12.

Richard I and Philip Augustus, although only with reference to the Holy War; and even a hundred years later, in the time of Edward I, St. George's flag, although prominent amongst flags, is not more so than St. Edmund's—blue, with three gold crowns, or that of St. Edward the Confessor—blue, with a gold cross fleury between five martlets.[1] But though on shore these seem to have held equal rank as military emblems, it may be doubted whether they were ever so considered afloat. It is at least certain that by the middle of the 14th century, and during the Hundred Years' War, St. George's cross was distinctly marked on the flags of English ships; and though borne with some other individual cognizance, was known and recognized as the badge of English nationality.[2] So also on shore. A series of orders, which may be called "Articles of War," has come down to us, dating from the time of Richard II; as there was no active war with France in his reign, their origin is probably from the days of his grandfather. But this is one of them:—

"Every man, of what estate, condition, or nation he be of, so that he be of our "party, shall wear a sign of the arms of St. George, large both before and behind; "upon peril that if he be slain or wounded to death, he that hath done so to him "shall not be put to death, for default of the cross that he lacketh. And no "enemy, whether prisoner or not, shall wear the said sign of St. George, upon pain "of death."[3]

A white cross was, in the same way, the badge of French nationality, and was worn by French ships; and there seems reason to believe that, during the minority of Henry VI, whilst the two countries were nominally one, the two crosses were combined. I think that, at this time, the flag may have been blue, with a white cross charged with a red cross; and though, in the absence of any positive evidence, this is and must be doubtful, it is at least recorded that the Duke of Bedford, as Regent of France, wore a blue surcoat so charged with the two crosses.[4]

If, however, any such flag was ever in use, it would be but for a short time, and would die out at once on our being driven out of France a few years later. From that time until the accession of James I, the red cross on a white field was certainly the English flag. It was under it that the great seamen of Elizabeth's time traded, or explored, or fought; it was this flag that Drake and Cavendish bore round the world, that Lancaster carried to the East Indies, or Frobisher to the far north; that flew triumphant against the Spaniards off Gravelines, on the 29th July, 1588, or with less good fortune, though with not less glory, waved o'er the shot-torn wreck of the "Revenge," off Flores, on the 1st September, 1591. What Englishman is there whose blood has not coursed more quickly through his veins, who has not felt prouder of his name, his country, and his flag, as he has read in the Laureate's sonorous verses how—

[1] Nicolas's "Siege of Carlaverock."
[2] Nicolas's "History of the Royal Navy," vol. ii, p. 181.
[3] Nicolas's "Battle of Agincourt," p. 110. See also "The Black Book of the "Admiralty," vol. i, p. 456.
[4] Vallet de Viriville: "Histoire de Charles VII," vol. i, p. 414.

" —— the sun went down, and the stars came out far over that summer sea,
" But never a moment ceased the fight of the one and the fifty-three :
" Ship after ship the whole night long, their high-built galleons came ;
" Ship after ship, the whole night long, with her battle-thunder and flame ;
" Ship after ship, the whole night long, drew back with her dead and her shame ;
" For some were sunk, and many were shattered, and so could fight us no more ;—
" God of battles ! was ever a battle like this in the world before ? "

It was amid such scenes of all-abiding honour that the reign of the St. George's flag pure and simple came to an end. On the 12th of April, 1606, it was ordered by James I that—

" Henceforth all our subjects of this isle and kingdom of Great Britain and the
" members thereof, shall bear in their main-top the red cross, commonly called
" St. George's cross, and the white cross, commonly called St. Andrew's cross,
" joined together according to a form made by our heralds and sent by us to our
" Admiral, to be published to our said subjects. And in their fore-top our subjects
" of South Britain shall wear the red cross only, as they were wont ; and our
" subjects of North Britain, in their fore-top, the white cross only, as they were
" accustomed."

The union so ordered is blazoned :—azure, a saltire argent, surmounted of a cross gules, fimbriated of the second : as to which fimbriation a very interesting question arises.

It has often been said that this combination of the two crosses is heraldically incorrect ; that they ought to have been quartered. Had they been considered merely as armorial bearings, this would perhaps have been true ; but the rules of heraldry admit of very irregular modification when applied to flags ; and I have already told how, a century and a half earlier, and when heraldic science was a more living reality than it was in 1606, the Duke of Bedford had combined the crosses of England and France, if not in a flag, at least on his surcoat, in a manner very similar to that in which the crosses of England and Scotland were now joined. I have nowhere seen it stated as a fact, but it seems possible that the heralds of King James I were, to some extent, guided by a note or tradition remaining in the office from the time of King Henry VI ; and the breadth—as officially ordered—of the so-called fimbriation seems to me to give very great weight to this idea. A fimbriation is, heraldically, a narrow border to prevent the unpleasing effect of metal on metal, or colour on colour ; it should be as narrow as possible to mark the contrast. But the white border of our St. George's cross is and always has been officially ordered to be one-third of the width of the cross itself ; it is not, strictly speaking, a fimbriation at all ; it is a white cross, of one-third the width of the flag surmounted of a red cross, one fifth of the width ; all which is in exact heraldic proportion, just as it would be arranged by the Duke of Bedford.

I put it, therefore, before you as a suggestion, possible, I think probable, and certainly pleasing, that the width of the white border to our modern St. George's cross carries us back, through nearly 500 years, to the memory of that glorious day of St. Crispin, 1415.

The correspondence between the colours of this possible and probable combination of the crosses of England and France and those of the now existing combination of the crosses of England and Scotland, though not

directly connected with the English dominion in France, is so, to some extent, indirectly. It is not a mere matter of chance that France and Scotland wore, in their early days, the same colours. The long and intimate connection between the two countries may well have led the Scotch to adopt the colours of their great ally, whilst preserving the national form of the cross—the saltire, or cross of St. Andrew, the patron saint of Scotland, strictly from time immemorial.

Legend has, indeed, a widely different origin for the colours of the Scotch flag. It appears that, once on a time, a certain Achaius, King of the Scots, and his ally, one Hungus, King of the Picts, had marshalled their forces in East Lothian, to do battle with an Athelstan, King of the Saxons; and being much inferior in numbers they applied to St. Andrew for assistance. As a signal that their prayer was heard, the saint's cross appeared, white in the blue sky; encouraged by which they rushed on and won a complete victory. The story has absolutely no foundation in fact; there was no Achaius, no Hungus, no Athelstan; and though, doubtless, there were plenty of battles in Lothian, there was no interposition of St. Andrew. The colours are indubitably as French as the modern Scotch name for a leg of mutton or a dish to put it on, and may most probably be dated to the end of the 14th or the early part of the 15th century.

The union flag of Great Britain, although appointed by royal order in 1606, was not till long afterwards worn in the ensign; which however, during the 17th century, was no longer the simple old flag of England. The impetus which had been given to our naval development during the reign of Elizabeth continued during that of James I, and through the century; and the tactical necessities of large fleets led to their divisions and subdivisions being distinguished, each by its own flag. In this the English Admiralty was beyond doubt guided by the old usage within the Straits, amongst the Venetians or Genoese: in accordance with which the fleet was divided into three squadrons—the centre or red, the van or blue, and the rear or white—and each of these squadrons was subdivided into three, respectively commanded by an Admiral, Vice-Admiral, and Rear-Admiral, carrying their distinguishing flags at the main, fore, and mizen top-gallant mast-head, as at present. But as the Admiral commanding in the centre was not only in command of the red division, but of the whole fleet, he flew, not the red flag, but the union at the main; there was thus no Admiral of the Red. The second in command flew a blue flag at the main and the union at the fore; the third, in command of the rear, flew a white flag at the main and the union at the mizen. But the Lord High Admiral, when personally in command of the fleet, and sometimes also other Commanders-in-Chief, flew, as their flag of command, not the union, but the standard—a flag now only used by the Sovereign in person, or as a decoration on royal fête days.

I believe there is not any record of an Admiralty order dividing and subdividing the fleet in the manner I have just detailed, nor was any such record to be found two hundred years ago. In 1687 the question seems to have been raised, and to have been carefully examined into by Mr. Pepys, then the Secretary of the Admiralty; and

according to the evidence he collected, it appears that the first occasion of so dividing the fleet was in the expedition against the Isle of Rhé, in 1627, under the immediate command of the Lord High Admiral, the Duke of Buckingham, who flew the standard at the main.

The desire fully to distinguish the different squadrons led at the same time to a change in the ensigns. These were made of the three colours, having in the upper corner, next the staff, a white canton charged with St. George's cross. The early evidence of this is painfully certain. The expedition against the Isle of Rhé was one of the many opportunities the Duke of Buckingham had to disgrace the name and the flag of England; our troops were repelled with great loss, and forty flags, then captured, were carried in triumph before the people of Paris, and deposited in Notre Dame. The description of them, to which I refer, was given by the poet Malherbe, an eye-witness of the triumphal procession.[1]

The usage which I have described continued during the reign of Charles I; but on his violent death, the union flag was done away with: the Parliament professed to be the Parliament of England only, and of its dependency, Ireland; with Scotland, as a part of the kingdom, it had nothing to do; the Scotch cross was expunged from the flag; and the blue colour, the colour of Scotland, which under the Stuarts had been ranked second only to the red of England, although, for tactical convenience, still retained, was pushed down to the third place. Nevertheless, the tactical distinctions were judged so important and necessary, that the ensign did not revert to its original simplicity, but continued, as under the Stuarts, to bear the cross in a canton. The flag of command ordered to take the place of the union, and to be borne by the Admirals at the main, fore, and mizen, is described under date 5th March, 1649, as "the one now presented, viz., the arms of England and "Ireland in two escutcheons, on a red flag, within a compartment or." This was described by Mr. Pepys, when Secretary of the Admiralty, as encircled by a laurel wreath for the Admiral, but plain for the Vice and Rear-Admirals. Whether at the same time the ensigns had the harp on the fly, or not, is a matter of some doubt: I myself think they had; but I know that others who have carefully considered the subject think they had not. It may be considered as certain that the flag bearing the cross and harp in a compartment was worn by the Admirals of the respective squadrons; and the official order of February, 22nd, 1649, is for "Ships in service of the State to have "only a red cross on a white ground as a flag," from which it is fairly enough inferred that this, the old St. George's flag, was the ensign under the Commonwealth. I think rather that the order I have just quoted affected only the union flag, which the king's ships had hitherto worn at the bowsprit; and that as no order appears altering the ensign from its primitive simplicity, so now it continued as before, if indeed not bearing also the harp. On that point the evidence is defective; but—1stly, Mr. Pepys, under date 13th May, 1660, says that a council of war was held, "to acquaint *them* that the harp must be

[1] Beneton: "Commentaire sur les Enseignes de Guerre," p. 129.—Oeuvres de Malherbe, (Edit. Lalanne, 1862); tom. iv, p. 68.

"taken out of *all* their flags, it being very offensive to the King." Does *them* refer to only two Admirals? or can "*all* their flags" refer to only two flags of command? I think not: 2ndly, an account of stores dated 7th February, 1661, mentions some old moth-eaten colours, "the flags and jacks with a cross and harp."[1] From which it would seem that the harp was in other flags than the Admiral's flags of command: and 3rdly, contemporary prints, often very rude, coarse wood-cuts, show the English flags with the cross in the canton, not over all; and in particular, the engraving of the Dutch medal commemorative of Tromp's death[2] shows the harp in the fly. Such pictures are to be counted as evidence only with very great caution, but in this case they are contemporary, and could not have invented the flag with the cross in the canton, the harp in the fly; though they may very well have shown it in the wrong place, at the English Admiral's main-top-gallant-mast-head.

However this may be, the Admiral's flag during the Commonwealth was assuredly the cross and harp. Off Portland, on the 18th February, 1653, Blake, with whom was Deane, commanded in chief on board the "Triumph," with the cross and harp at the main. Monk, who was altogether out of the battle, was Admiral of the white division. I presume, therefore, that he had the cross and harp at the fore; and that Penn, who commanded the blue division, the actual van, and whose ready gallantry saved the day, had the Admiral's distinctive flag at the mizen. This would be, under the circumstances, the natural order of things; although Penn, being by commission Vice-Admiral of the Fleet, had so far a right to carry the flag at the fore; and Lawson, who, on this occasion, was serving as Vice-Admiral of the Red, held a commission as Rear-Admiral of the Fleet, and might therefore have claimed to wear the cross and harp at the mizen. We may perhaps wonder why Deane, holding a commission as General at sea, equal though junior to Blake and Monk, did not take personal command of the blue division, as Monk did of the white; but it is impossible not to feel that by his not doing so, and the command of the van so falling to an experienced seaman, England was saved from a very great danger.

On the Restoration, in 1660, the union flag was re-introduced, but the precedence of the three colours remained as it had been determined by the Commonwealth. An order was given that the standard should only be worn by the Duke of York, or Prince Rupert;[3] but throughout the reign of Charles II, it was worn also by Monk, and, sometimes at least, by Mountagu.

How closely related the tactical system of the day was to the divisions and subdivisions of the fleet, how distinct was the difference between the squadrons, is curiously and painfully illustrated by the misfortunes of the white flag in the great four days' battle off the North Foreland, on the 1st, 2nd, 3rd, and 4th of June, 1666. To meet a squadron of the French, falsely reported to be in the Channel,

[1] "Calendar of State Papers." Domestic. 1660–61, p. 505.
[2] Basnage: "Annales des Provinces-Unies," tom. i, p. 316.
[3] "Calendar of State Papers." Domestic. 5th July, 1665.

Prince Rupert had been detached, taking with him "the whole white "squadron, except only the Admirals."[1] Why the Admirals were left behind does not appear, but the result seems to have been that in the battle they were comparatively unsupported; the Admiral of the White (Sir George Ayscough), with his ship, the "Royal Prince," and his flag were taken; the Vice-Admiral of the White (Sir William Berkeley) was killed, his ship, the "Swiftsure," and his flag taken; and the Rear-Admiral of the White (Sir John Harman) was himself badly wounded, and his ship, in a sinking condition, towed into Harwich. Of the many other brave men who fell on both sides in that most murderous of battles, I have nothing now to say; but the facts that the three Admirals of the White went into the battle without their squadron, that two of their ships were captured, and that the third had a very narrow escape of being destroyed, seem to me to prove that the flags, with their different colours, had a very important value in the ordering of the battle, and perhaps more especially in a battle fought, as this is said to have been, "promiscuously."[2]

In the great fleets of 1672 and 1673, our allies, the French, formed the white squadron, the English being divided into the red and blue, and all under the English standard. In 1690 and 1692, off Beachy Head and Barfleur, the Dutch squadron was in the van, the English red and blue forming the centre and rear; the Commander-in-Chief on these occasions flying the union at the main. So also did Sir George Rooke, in command of the allied fleet at Vigo, in 1702, and off Malaga, in 1704.

On the political and constitutional union with Scotland, in 1707, the union flag which had hitherto been borne as a mark of command at the top-gallant-mast-head, or, as the mark of a King's or Queen's ship at the head of the spritsail-topmast, was inserted in the ensign, then and for long after, always worn on a flag-staff; never at the peak. I may point out how this inquiry into the custom and use of flags brings up many questions of naval archæology. At the time of which I am here speaking, the mizen yard, or balanced mizen, had not given place to the gaff of modern days; nor had the spritsail-topmast been resolved into its modern equivalents, the jib-boom and the jack-staff. This, however, is merely by the way. Previous to May, 1707, the ensign of English ships of war showed only the English cross in the upper canton, next the staff; but from this time that canton bore the union of St. George's and St. Andrew's crosses, and the white ensign, as we still know it, was quartered by the St. George's cross.

It is perhaps only a coincidence, that with this introduction of the union into the ensign, it almost entirely ceased, in practice, to be worn as a flag of command. The large fleets of 90 or 100 sail were no longer gathered together; the Fighting Instructions, prescribing fighting in line-of-battle ahead, were received as the basis and perfection of naval tactics, and the old tactical subdivisions came to an end. On the other hand, the different grades of command were better defined; and from this time the different colours of red, white, and blue ceased

[1] "Columna Rostrata," p. 167.
[2] "Pepys's Diary," vol. ii, p. 409 (Bohn's edition).

to have any meaning, beyond that of marking degrees of seniority. The Commander-in-Chief of a fleet might be, as occasion ruled, an Admiral, or a Vice or Rear Admiral, and carried the flag of his colour at the mast-head corresponding to his rank; so that the anomaly was often seen of the inferior colour commanding the superior. Off Toulon, on the 11th February, 1744, the colours were exactly reversed, Mathews, the Commander-in-Chief, being an Admiral of the Blue; Lestock, the second in command, a Vice-Admiral of the White; and Rowley, commanding in the third post, a Rear-Admiral of the Red. Off Minorca, on the 20th May, 1756, the Commander-in-Chief was Admiral of the Blue; so also in Quiberon Bay, on the 20th November, 1759; off Ushant, on the 27th July, 1778; and off Cape St. Vincent, on the 14th February, 1797. At the battle of the Nile, on the 1st August, 1798, Sir Horatio Nelson, then Rear-Admiral of the Blue, ordered all the ships to fly the white ensign; so too at Trafalgar, where though he himself was a Vice-Admiral of the White, Collingwood, the Commander of the lee line, was a Vice-Admiral of the Blue. With the exception of Sir George Byng, on the coast of Sicily, in 1718, and of Sir John Norris, during his inglorious command in the Channel, in 1744, no Admiral carried the union at the main, between 1704 and 1794; when Lord Howe wore it during the campaign which culminated in the battle off Ushant, on the 1st of June, and, in relation to it, ordered the several flag officers under his command to wear their flags and colours according to the original meaning of the distinction, and not according to the purely personal differences, as shown in the Navy List. The flags worn in this battle have thus an interesting reference to Lord Howe's tactical studies, and the list of them is worth noting:—

100, "Queen Charlotte," Admiral Lord Howe; union at the main.
100, "Royal Sovereign," Vice-Admiral (Red) Thomas Graves; white at main.
100, "Royal George," Vice-Admiral (Red) Sir Alexander Hood; blue at main.
98, "Barfleur," Rear-Admiral (White) George Bowyer; red at fore.
98, "Impregnable," Rear-Admiral (White) Benjamin Caldwell; white at fore.
98, "Queen," Rear-Admiral (White) Alan Gardner; blue at fore.
74, "Bellerophon," Rear-Admiral (White) Thomas Pasley; white at mizen.

But all ships, without distinction of squadron, flew the red ensign.[1]

On the other hand, in the battle under the lee of Dominica, on the 12th of April, 1782, Sir George Rodney, Admiral of the White and Vice-Admiral of the United Kingdom, flew his white flag at the main of the "Formidable," and the ships of the centre with him flew the white ensign; whilst the divisions under Hood and Drake, both Rear-Admirals, flew their respective colours, red and blue. I find no mention of Rodney having at any time worn any flag denoting his rank as Vice-Admiral of the Kingdom; nor, so far as I can ascertain, has

[1] "Naval Chronicle," vol. i, p. 28.

any such flag ever been worn as a mark of command. Neither indeed has the flag of the Lord High Admiral, or of the Commissioners for executing the office. Whenever the Lord High Admiral in person has commanded the fleet, he has flown the standard; and though on any future occasion it would, of course, be within his option to fly the red flag, with the yellow foul anchor in fess, at the main, there is no historical precedent for his doing so; the flag has been merely an honourable distinction, a symbol of civil or administrative but not of executive rank.

The beginning of the present century brought another change to our flag. Ireland became an integral part of the United Kingdom in 1800, and by order of the 1st January, 1801, the union flag was altered to mark the accession. As to the cross then introduced, a great deal of nonsense has been talked, and indeed, to some extent, officially recognized. It has been called the cross of St. Patrick, in defiance of all Church tradition. St. Patrick never had a cross; the cross saltire, so far as it belongs to any saint, is sacred to St. Andrew; but the Irish saltire, and I think probably also the Scotch, is the sacred monogram devised by, or revealed to, Constantine the Great. The early Christianity of Ireland and the missions to Scotland may very well have adopted it; the form is that of the *Labarum*, but the colours are English.[1] It is thus that from the early conquest of Ireland, the FitzGeralds have borne as their arms, argent, a saltire gules; and I find the same shown as the flag of Ireland in the beginning of last century;[2] although, of course, Ireland never had what could properly be called a national flag. It was, however, sufficiently so to be acknowledged in 1801, and combined with the white saltire already in the union. The two are counterchanged: the white, as representing the senior member of the union, being uppermost in the first quarter, and the red, edged with white, as a fimbriation. I often hear it asked why the border of the St. Patrick's cross is narrower than that of the St. George's? The border of Ireland's red saltire is a fimbriation, and has no other meaning. I have already shown you that the border of the St. George's cross is possibly a different thing altogether.

Four years after this change, and as a special compliment to the Navy after the battle of Trafalgar, a rank of Admiral of the Red was instituted; this was officially notified on the 9th of November, 1805, in these words:—

"His Majesty, having been pleased to order the rank of Admiral of the Red to be "restored in His Majesty's Navy, the following Flag Officers were this day pro- "moted, in pursuance of the King's pleasure." [22 in number.]

This of course was a very tangible boon, promoting, as it did, twenty-two Officers of every grade throughout the service; but the King's advisers fell into a curious though not original mistake, when they wrote of *restoring* the rank. Statements have often enough been put

[1] For this solution of a very vexed question, the only probable solution that I have met with, I am indebted to the friendly assistance of Captain R. M. Blomfield, R.N.

[2] "L'Art de Batir les Vaisseaux." Amsterdam. 1719.

forward to the effect that the red flag was lost in a battle with the Dutch, and that the rank was done away with as a mark of disgrace: they are entirely untrue; and though, as I have told, the white flag was once captured, there was no disgrace attending its loss. It has also been said that the red at the main was changed into the union in 1707; this also is incorrect: the Commander-in-Chief of the Fleet flew the union from the very first introduction of distinguishing colours, whenever, at least, he did not fly the standard. As a matter of fact, the rank of Admiral of the Red was instituted for the first time in 1805. I have already explained how it was that no such grade was called for, or indeed possible, during the 17th century; and though during the 18th, when the colours had ceased to have a tactical meaning, there was no reason why there should not be an Admiral of the Red, there was, on the other hand, no reason why there should be; and there never was.

But notwithstanding the new and honourable accession of colour, the distinction having lost its original meaning, was felt to be no longer anything but a source of irregularity, confusion, and needless expense. It was therefore after, I must say, much long-suffering, abolished by Admiralty Order of the 5th of August, based on the Order of the Queen in Council, dated 9th of July, 1864. In this it is ordered that—

"Admirals, Vice-Admirals, and Rear-Admirals shall in future wear respectively a "white flag with the Red St. George's cross therein at the main, fore, or mizen top-"gallant masthead.

"All Her Majesty's ships of war in commission shall bear a white ensign with a red "St. George's cross, and the union in the upper canton."

Ships and vessels employed in the public service are to fly the blue ensign; ships commanded by Officers of the Royal Naval Reserve, and having one-third of their crew men of the Reserve, may also fly it; yachts and others under special authority may fly distinguishing flags, but all other British ships are to fly the red ensign. And this order is still in force.[1]

From a very early date the Kings of the Franks marshalled their armies under a blue flag, known as *La Chape de St. Martin*, which, it is now generally acknowledged, was not really St. Martin's cloak, but a memory of it. Afterwards, they began to use also a red flag with a green border or fringe, considered as sacred to St. Denis, and known as the *Oriflamme*. This, by little and little, grew in popular estimation, until, by the end of the 10th century, it was recognized as distinctly and pre-eminently the royal standard; and that, although the blue flag never lost its claim. The exact time when this blue flag was

[1] I may here note that, according to the existing regulation, a union flag is twice as long as it is wide; and taking the width as the unit of measurement, the red St. George's cross is $\frac{1}{5}$, and its white border $\frac{1}{15}$; the white of the St. Andrew's cross is $\frac{1}{10}$; the red of the (so-called) St. Patrick's cross is $\frac{1}{15}$, and its white border is $\frac{1}{30}$. The lines in which the white and red of St. Andrew and St. Patrick (so-called) meet are diagonals of the flag. In the white ensign the breadth of the large cross is $\frac{2}{15}$ of the width of the flag.

charged with *fleurs-de-lis* must be a matter of doubt; and for this reason: that the device is one of extreme antiquity, the emblem of a very old and long-forgotten worship; older, by thousands of years, than the doctrine of the Trinity, of which the flower has been supposed to be the emblem. It is thus that the device appears in many places, without any evidence that it was accepted as peculiarly French or royal. It may be admitted that it was so accepted during the 12th century, perhaps during the 11th; and that from the first recognition of coats of arms, the blue field, powdered with golden lilies, was the cognizance of the French Kings. From that time until the Revolution, the lilies were as distinctly the emblem of France, as the lions were and are of England, although, in course of time, the bearing became more exact; and from the early years of the 15th century the blue field was no longer powdered with lilies, but charged with three, that is, two and one. The lately abolished eagle was altogether a creature of the Republic and Empire; and, except as a whim of Louis XIV, the Gallic cock had no real existence.

So much for the French standard; but the national flag from a very early period bore the white cross. There is the same doubt about this as about the red cross of England; but it would seem certain that, by the middle of the 14th century, the white cross on breast and back was the distinguishing mark of French soldiers; and a blue flag, with the same white cross, the distinguishing mark of French ships, so far as they were recognized as French, and not part of a provincial militia, or personal following.

The factions which, in the beginning of the 15th century, tore France to pieces, were marked by a white scarf on the one side, a St. Andrew's cross on the other; and the assumption of this latter, which became the cognizance of Burgundy, may be fixed pretty accurately at the year 1410 or 1411,[1] when it was certainly worn; whereas a few years before, in 1405, the Duke of Orleans bore on his banner a ragged staff, or, in plain English, a cudgel, and the motto *J'ai l'envie* —I've a great mind to; which was answered by the Duke of Burgundy bearing on his banner a carpenter's plane, and the motto *Ik houd*, I hold—that is to say, am ready for you; and in 1407, on the murder of the Duke of Orleans, the common saying in Paris was, that the knots of the cudgel had been well planed down. The St. Andrew's cross was probably enough worn by Burgundy in reference to the patron saint; but it was possibly in very unsaintly reference to the feud, and to this planing down, that the cross was made of two ragged staves, or, in heraldic language, a saltire, raguled; and I have little doubt that the colours, red on a white field, were fixed in 1420, in reference to the alliance with England against the Dauphin.

Afloat, the usage of personal colours extended far later amongst the French than amongst the English. As late as 1543, there is a royal order for "All ships in the service of the King to carry the banners "or ensigns of the Admiral of France."[2] Annebault, who was Admiral of France from 1543 to 1552, commanded the fleet which invaded the

[1] Menestrier: "Origine des Armoiries," p. 200.

[2] De Bouillé: "Les Drapeaux Français," p. 221, 2nd edit., 1875.

Channel in 1545, and his arms were gules, a cross vair. It is therefore probable that the French ships at St. Helen's, in that year, wore flags, gules with a cross vair, and that the pennons and pavesades were red, blue, and white. It is, of course, also probable that with these were worn the blue flag with the white cross, and many others, provincial or local.

Notwithstanding all that French writers, for political purposes, have put on paper in these modern days, I find no trace of the white flag as a national ensign, or colour, before the time of Henry IV. It is quite true that a white flag, with the picture of the Crucifixion, was borne by Joan of Arc, and by the French armies which, under her inspired leading, won back France for a cold-blooded and ungrateful King. But between that distinctly religious flag and the white scarfs and colours assumed by the Protestants a hundred years later, I can trace no connection. The Catholic army wore first red; then green—the colour of the House of Lorraine; and after the murder of the Duke and Cardinal de Guise in 1585, black, till the death of Henry III, when they resumed the green. But throughout, from 1562, the Protestants wore white, principally as a distinguishing mark, but also, no doubt, as an emblem of that superior purity which they claimed for themselves[1]. When Henry III joined with them, they did not change their colour, which, being worn by the King, thus became royal, and so continued. The principal standard of the League, captured at the battle of Ivry, 14th March, 1590, was black, charged with a crucifix, and the device AUSPICE CHRISTO, but with green tassels. The royal flag was blue, with the golden lilies, though white was recognized as a party colour. Everybody knows how, before the battle, as he marshalled his men, the King had—

> "—— bound a snow-white plume upon his gallant crest."

and also how he cautioned them—

> "And if my standard-bearer fall, as fall full well he may,
> "For never saw I promise yet of such a bloody fray,
> "Press where ye see my white plume shine amidst the ranks of war,
> "And be your Oriflamme to-day the helmet of Navarre."

The wars of the League and the battle of Ivry are not exactly naval, but they must serve to mark the introduction of the white flag, which became from that time royal and national, as opposed to other flags of provinces or towns, or to the old flag, blue with the white cross, still borne by merchant or private ships. The flags are so distinguished by Fournier in 1643,[2] but how very uncertain they were appears from a letter of M. d'Infreville, the Intendant of Toulon, in 1665.

"The 'Saint-Philippe' (he says) is so richly gilt, that to be in keeping with such "splendour, she ought to have a new flag of crimson damask, bearing the arms of "France, and powdered with *fleurs-de-lis*, and crowned *LL*'s in embroidery. The "old one, which was made at Paris for the Archbishop of Bourdeaux, twenty-eight "years ago, at a cost of 12,000 livres, is torn away to half its size, and is quite a "rag."[3]

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[1] De Bouillé, p. 262. [2] "Hydrographie," p. 94.
[3] "Abraham du Quesne et la Marine de son Temps," par A. Jal: tom. i, p. 330.

It was not till 1669 that an order was given, reducing the chaos of flags to something like regularity; and then, whether by mistake or not, it was decreed, on the 6th November, that—

"The ensigns at the stern are to be blue, powdered with yellow *fleurs-de-lis*, with "a large white cross in the middle; without distinction of peace or war, voyage or "battle.

"Merchant ships may wear the same ensign as our ships of war, with the "escutcheon of their province or town in one of the corners.

"The pavesades are to be blue, powdered with yellow *fleurs-de-lis*, bordered with "two broad white bands."[1]

But, on the 13th December of the same year, a new order came out:

"The ensigns at the stern are to be in all cases white;" merchant ships the same, with the escutcheon as before.

It was thus certainly under the white flag that the French squadron served as the white division of the allied fleet in the iniquitous war, 1672–3, and in all future battles for more than a century. About the same time they divided their fleet, as the English and Dutch had earlier done. At Beachy Head in 1690, at Barfleur in 1692, and on till the Revolution, their squadrons were — centre, white at the main; van, blue and white, horizontal (party per fess); rear, blue; the Vice and Rear Admiral of each squadron wearing the flag at the fore or mizen, as at first in our own fleets—with this difference, however, which I conceive, was, so far as it went, in favour of the French: that the systematic division of the fleet continued virtually in force, so that all through the wars of the 18th century, the three squadrons of the French line of battle were distinguished by the three flags at the main; subordinate Flag Officers wearing the flag of their squadron at the proper mast, according to their relative command, not according to absolute rank; for, as a matter of fact, from 1704 downwards, with the exception of the Marquis de Conflans and Count d'Estaing, who were Vice-Admirals, no Officer of higher rank than Lieutenant-General, corresponding to Rear-Admiral, commanded a French fleet. Gallisonière at Minorca, in 1756, was a Lieutenant-General. La Clue and Glandevez, his subordinates, were Commodores. So also, in the action with Keppel off Ushant, in 1778, D'Orvilliers, the Commander-in-Chief, Duchaffault, the second in command, and the Duke de Chartres the third, were all Lieutenant-Generals; but the Vice and Rear Admirals of the several divisions were all Commodores or Captains; which last case is provided for by a particular instruction:—

"If the commanders of divisions are not general Officers, they may carry, for "distinction, a swallow-tailed flag of the colour of the squadron; longer and nar-"rower than a flag of command, but shorter and broader than a pennant."[2]

After the battle off Ushant, M. d'Orvilliers seems to have reported, amongst other things, that the identity of the flag of the blue division with the English blue flag,—worn on that occasion, it will be remem-

[1] "Abraham du Quesne et la Marine de son Temps," par A. Jal: tom. i, p. 588.
[2] "Tactique Navale," par le Vicomte Morogues: p. 107.

bered, by two out of the three English Admirals,—caused, and was liable to cause, confusion and mistake. It was therefore modified by the reintroduction of the old white cross, and was so worn during all the subsequent events of that war, and especially in the West Indies, against Rodney.[1]

With the Revolution all this was done away with; the spirit of change seized on the flag, as on everything else, and decreed, the 24th October, 1790, that—

"The flag on the bowsprit (jack) shall be composed of three equal bands, placed "vertically: that next the staff shall be red, the middle white, and the third blue.

"The flag at the stern shall carry in its upper quarter the jack above described; "this shall be exactly one-fourth of the flag, and shall be surrounded by a narrow "band, the half of which shall be red and the other blue; the rest of the flag shall "be white. This shall be the same for men-of-war and for merchant ships.[2]

"The flags of command shall carry in their upper quarters the three vertical bands, "red, white, blue; but the rest of the flag shall be, as heretofore [which is a curious mistake], red, white, or blue; the National Assembly having no desire to change in "any way those dispositions which have been made to distinguish the three squad-"rons of a fleet."

The origin of the tricolour has been much disputed by later French writers, some of whom have endeavoured to trace it back to the liveries of Henry IV, to the arms of Annebault, or possibly to the *oriflamme* of St. Denis, the *chape* of St. Martin, and the white of the Bourbons. I think, however, we may almost conclude that it was formed by grafting the old colours of Paris—red and blue—of absolutely unknown origin—on to the white. And this seems to have been the opinion of the Convention which, in 1794, abolished the flag I have just described, as savouring of royal, or, from its mode of quartering the jack, even of English tendencies. On the 15th of February it was decreed that—

"The flag prescribed by the National Assembly is abolished.

"The national flag shall be formed of the three national colours in equal bands, "placed vertically, the hoist being blue, the centre white, and the fly red."[3]

An interesting question then occurs, whether, considering the date of this decree—the 15th February, 1794—the flag of the National Assembly was actually suppressed on the First of June. The great picture by Loutherbourg, in the Painted Hall at Greenwich, represents the French ships as wearing the suppressed flag; and though the painter has made some grave mistakes in the positions of the ships,[4] driven thereto, apparently, by the exigencies of his art, I see no reason to believe that he was mistaken in the flag, samplers of which had been captured by the dozen, and were no doubt put at his disposal. We must then suppose, what, under the circumstances, is probable enough, that between the 15th February and the 16th of May, when the fleet sailed out of Brest, the new flags could not be made in sufficient numbers. However that may be, the new flag—the flag of the Convention—was certainly the flag of the French Navy during the

[1] Rey: "Histoire du Drapeau," tom. ii, p. 578.
[2] De Bouillé, p. 244. [3] *Ibid.*, p. 247.
[4] See James' "Naval History," vol. iii, p. 473 (edit., 1860).

Republic and Empire; and though, on the return of the King, in 1814, and, again, in 1815, it was abolished, and the white flag restored, French sentiment clung to the tricolour, and re-introduced it in 1830. At the revolution of 1848, the Provisional Government, for no reason apparently but the mere desire for change, ordered (5th March) the colours to be blue, red, white at the fly, but two days later the opposition had set in so strongly that the order was cancelled, and the flag remained as it had been, and as it is.

Spain, from a mere geographical expression, becoming a great kingdom on the union of Castile and Aragon, and the development following thereon, used, as a national flag, the arms of Castile, which had from the first quartered those of Leon: the two, in fact, had never a separate existence: the same man that devised the pun on the name of Castile, devised also that on the name of Leon (*Legionensis Civitas*). But long before that, Barcelona ships had worn the red and yellow stripes, known as the bars of Aragon. The old story is that, in the year 873, Charles the Bald honoured Geoffrey, Count of Barcelona, who had been mortally wounded in a battle against the Normans, by dipping his four fingers in the blood flowing from the Count's wounds, and drawing them down the Count's golden shield. The story is pure fable; for the stripes, not so old by some 200 years, are merely a pun on the name of Barcelona; they are *barras longas*. Afterwards, as Barcelona merged into the Kingdom of Aragon, its arms were adopted as those of the kingdom. But though known in the Mediterranean, they scarcely came into the Western Sea; and from the first greatness of Spain her ships wore the Castilian flag, quartering Castile and Leon. It was this, as a national flag, that was worn by the ships of Columbus: but Columbus had also, as a personal flag, one given him by Queen Isabella, which is described as a white swallow-tailed banner, bearing a Latin cross in green, between the letters F. Y., crowned. These two flags, then, are noteworthy in the history of navigation, as the first across the Atlantic.

On the accession of Charles V to the Kingdom of Spain, it would seem that he introduced the Burgundian flag—the red raguled saltire on a white ground, that I have already spoken of. It may be a matter of surprise that a people so proud as the Spaniards should consent to adopt the flag of another principality; it was probably considered as the flag of Charles rather than of Burgundy, and its well-marked simplicity seemed to point it out as a naval ensign. It is, at any rate, quite certain that it became the Spanish flag, and to some extent continued to be so for more than 250 years. Whether the Spanish galleys at Lepanto, in 1571, wore this flag or not I cannot determine, but I think not. The fleet was divided into four squadrons, or divisions: centre, blue; right, green; left, yellow; and rear, white.[1] But besides these purely tactical flags, the galleys no doubt wore flags of their own nationality; and the greater number of the Spanish galleys at Lepanto were Sicilian or Neapolitan; others were Aragonese;

[1] Pantero Pantera: "L'Armata Navale;" p. 202.

and the Genoese galleys were in Spanish pay. Most probably they wore also the flags of their individual captain, and of such knights and gentlemen as were embarked on board them. But the ships of the Armada, in 1588, undoubtedly wore the Burgundian cross. In a series of maps of the actions, now in the British Museum, and dated 1588, the Spanish fleet is as distinctly marked by the red saltire as the English is by the red cross;[1] and M. de Bouillé tells us[2] that, in all the engravings of the 16th and 17th centuries representing the wars between France and Spain, the ships of the latter are always distinguished by the crosses of St. Andrew on the ensign. He adds that there are still in the Musée d'Artillerie several such flags, which have been captured from the Spaniards.[3] There is no doubt whatever that, during the latter half of the 16th and the first half of the 17th century, the Spanish flag was white with the red Burgundian cross; and a memorandum drawn up at Toulon, in 1662, signed by D'Infreville and others, says that—

"During the wars with Spain, our ships always wore in battle a red ensign at the "stern, to distinguish them from the Spaniards, who wore a white; but in the last "war with the English they wore white, as different from the English red."[4]

With the Bourbon marriage this seems to have been changed. I think it is to this time that we must attribute the introduction of the white flag bearing the royal arms, a flag similar, in effect, to the French standard. The old one was not, however, entirely abolished: and an order, dated 20th January, 1732, systematizes the complexity:—

"The King, having resolved that the ships of the fleet are to be divided into "three squadrons, and that each of these shall belong to one of the ports already "established in Spain, orders that every ship is to carry at the stern a white ensign "with the royal arms, as is now in use. And to distinguish the different squadrons, "those ships which belong to Cadiz shall wear as mast-head flags, or pennons, or at "the bowsprit cap, white with the royal arms. Ferrol ships shall wear white with "the Burgundy cross, charged at each of its four corners with an anchor. And "Cartagena ships shall wear violet (*morado*) with the shield of the castles and lions."[5]

In the plate in Harris's "Collection of Voyages,"[6] the Acapulco galleon, captured by Anson in 1743, is shown with the Burgundian flag at the stern, the white flag with the castles and lions at the main. The ships that fought under Navarro, off Toulon, in 1744, belonged to Cadiz; those that formed the squadron under Reggio, off Havana, in 1748, were, I think, from Ferrol. The Spanish contingent of the allied fleet that invaded the Channel in 1779, consisted of the Cadiz and Ferrol squadrons, though possibly ships from Cartagena may have

[1] These maps, which have no title-page of their own, are individually titled, "Rober. Adamo, authore, 1588. Augustinus Ryther, sculpsit." They belong to the translation, for Ryther, of Ubaldini's "Discourse concerning the Spanish fleete," but are bound up with Luke Waghenaer's "Mariner's Mirrour," 1588.

[2] P. 254, note.

[3] D. Antonio Canovas del Castillo, in an article "De la escarapela roja, y de las "banderas y divisas usadas en España," published in "La Illustracion Española y "Americana," 5th October, 1871, refers to numerous Spanish pictures of the early part of the 17th century, all showing the same red saltire.

[4] Jal: "Abraham Du Quesne," vol. i, p. 588, note.

[5] "Disquisiciones Nauticas," por el Capitan de navio C. F. Duro, p. 271.

[6] Vol. i, p. 354.

been joined with them: but throughout the War of American Independence no distinctive squadrons were fitted out from that port, and the head-quarters of the grand fleet under Cordova were throughout at Cadiz.

During these wars of the 18th century the white flag was found to be inconvenient, as so closely resembling, at a little distance, not only the pure white flag of France, but also the shield bearing white flags of Naples and Tuscany. It was resolved, therefore, to alter it; and after examining twelve patterns which were submitted, the existing flag was ordered by a decree, dated 28th May, 1785. In this the flag is defined as being in three horizontal stripes, the top and bottom red, each one-fourth of the whole breadth; the middle yellow, and on it the simple shield of Castile and Leon, quarterly, surmounted by the royal crown. The merchant flag was at the same time defined as having the yellow stripe in the middle, without the shield, one-third of the whole width, each of the remaining parts being divided into two equal stripes, coloured red and yellow alternately.[1] There is no doubt that the red and yellow then adopted was derived from the Aragon bars, being also the colours of the arms of Castile: but the Aragon arms are vertical; and I notice, as a coincidence that probably had weight in the decision, that the arms of Cordova, at that time the Commander-in-Chief of the Spanish Navy, were barry of seven, or, and gules.

Such as it was appointed in 1785 the Spanish flag has remained, with the exception of a nominal and short-lived change in the shield during the reign of Joseph Bonaparte, and a more real break during the disturbances from 1868 to 1875, when (if I am rightly informed) the revolutionary ships flew any flag they thought best, with a preference sometimes to plain red, as denoting the Commune; sometimes to a tricolour of violet, white, and red, apparently from some fancied idea that a tricolour is Republican. The red, yellow, red flag of 1785, but without the shield or crown, was ordered by the young King Alfonso XII to resume its place as the national ensign, on the 6th January, 1875.

Portugal, so closely bound to Spain by geographical position, has a history and a flag and a glory all her own. Her arms date from 1139, when Count Alfonso overthrew five Moorish Kings, and styled himself King of Portugal. The shields of the five Moors are prominent in the shield of Portugal. This formed the flag of the early discoverers; the flag that slowly pushed its way down the coast of Africa, and led the way round the Cape of Good Hope to the Indies. With that, Vasco da Gama carried also the armillary sphere, given him specially by the King, D. Manoel; and this flag, with the sphere in gold or red, was long known as the flag of Portugal in the Indies. The present flag, adopted in 1815, is but a modification—as far as I know an unmeaning modification—of the old and glorious flag of Prince Henry the Navigator.

Holland, as an independent State, had no existence and no national

[1] Duro, p. 273.

flag till the latter part of the 16th century. Before that time it had followed the fortunes of the Duchy of Burgundy, and had become incorporated in the dominions of the King of Spain; with them it had the Burgundian flag; and as the different ports were in the habit of using flags of their own, these were rendered illegal by a decree of 1540, to which I have already referred; but as early as 1475 all ships were ordered "to carry the arms and standards of the Duke:"[1] and again, in 1487, "to carry the banners and pennons of the Admiral, in "addition to any other local or special flags." It may, therefore, be considered certain that from these dates, down to the outbreak of the War of Independence, Dutch ships carried the Burgundian flag, the red raguled saltire on a white field; but from the very first discontents, the Gueux, who gave physical expression to their sense of wrong alike on sea and on shore, adopted the colours of the House of Orange—orange, white, and blue, which seem at first to have been worn promiscuously, or, so to say, at haphazard; though very shortly, to the cry of *Oranje boven!*—Up with the Orange!—they were ranged in horizontal bars, orange uppermost: but the number and order of the bars continued to be very much a matter of fancy till 1599, when the flag was definitely fixed as orange, white, and blue, in three horizontal stripes; although even then, and for a hundred years afterwards, this was not unfrequently doubled, and contained six stripes, but in the same order: and in the jacks on the bowsprit, or rather at the head of the spritsail-topmast, the three colours, in no certain order, radiated from the centre.

The orange at this time would seem to have been the distinctive colour. How it changed into red is doubtful. When standing into Gibraltar Bay, to annihilate the Spaniards, on the 25th April, 1607, Heemskirk wore an orange scarf, and in his hat a large orange plume. Fournier, writing in 1643, speaks of the Dutch flag as *red*, white, and blue; so that possibly the change was natural, from the similarity of colours, and had then well begun. But De Jonge, speaking from much official information and from old records and contemporary pictures, considers that the change did not begin till 1653, and then very gradually effected itself between that date and 1665; that the battles of the first war with England were fought under the orange, but that in the second war the colour was red. All the evidence however is positive, that in this second war the colours were as now, red, white, and blue; as, indeed, they have continued ever since, with the exception of a few years during the disturbances consequent on the French Revolution, when the flag of ships of war was distinguished by a white canton charged with a figure of Liberty, armed, with pike in hand, lion at feet. This was the flag worn by the Dutch ships at Camperdown; but that and other disasters did not endear it to the sailors, who yearned for the brave old flag with the glorious memories of De Ruyter, or the Tromps, father and son.

In 1806, after a dangerous mutiny, it was deemed expedient to restore the old flag; but by some omission the order was not general,

[1] J. C. De Jonge: "Over den Oorsprong der Nederlandsche Vlag." In Rey, vol. ii, p. 512.

and the ships of the Texel and the Zuyder Zee wore the old flag, whilst the ships of the Zealand squadron wore the new, with the brazen-faced Liberty in the corner,—a curious irregularity which continued till, on the 17th July, 1810, Holland and her flag were suppressed together, absorbed into the French Empire. Some of the Dutch settlements on the Coast of Guinea refused to acknowledge this absorption, and flew the old Dutch flag, keeping it, as it were, alive until the restoration of their country's freedom.

During the wars of the 17th century the great Dutch fleets were, like the English, divided into three squadrons, distinguished by the three colours—orange or red, white, and blue: and I think the Admirals of the three squadrons wore at the main, fore, and mizen respectively, the red flag charged with the golden lion rampant, holding a sheaf of seven arrows, the arms of the United Provinces; but I have not been able to determine this to my own satisfaction. I have sometimes thought that they wore this flag as an ensign at the stern, the three-coloured flag at their respective mast-heads, whilst the Vice and Rear Admirals of the Fleet severally wore the white and blue at the main. As an example of what I mean, I think that in the battle off Portland, on the 18th of February, 1653, Tromp, the Commander-in-Chief as well as leader of the fleet, wore the lion flag at the stern, and the orange, white, and blue at the main: that De Ruyter, the second in command, wore the lion at the stern, the three-coloured flag at the fore, and a white flag at the main; and that Evertzen wore a blue flag at the main, the national colours at the mizen, and the States' arms at the stern. But so far as I have been able to find out, the way in which these flags were worn was to a great extent optional, or left to the discretion of the Commander-in-Chief.

The rest of the European flags have so little direct connection with our English history, that I think that you will readily excuse me if I pass over them with but short notice.

The Belgian colours, black, yellow, red, are those of the Duchy of Brabant; they were formed into a national flag in 1831; clearly, on a French model.

The colours of Germany are those of the Teutonic order, black on white; the cross which is now always spoken of as "the iron cross," is the cross of the Teutonic order, and as such, dates from the closing year of the 12th century:[1] the red, as an imperial colour, is said to date back to the time of Charlemagne.

The Danish flag is absolutely the oldest now in existence; it dates from the 13th century, and, according to tradition, descended from Heaven ready made, in the year 1219, in answer to the prayer of King Waldemar, as he was leading his troops on to battle against the pagans of the Baltic. I see no reason to doubt that the King did really produce the banner on some such occasion, and assert its miraculous descent: but it is noteworthy that this, as all other Heaven-

[1] The history of the Teutonic Order in its connection with Prussia, is given at considerable length by Carlyle in the first volume of his "Frederick the Great."

sent crosses, is white; it is possible enough that Waldemar himself believed in the divine origin of his flag.

The Swedish flag seems to be merely the Danish, with the colours altered when Sweden won her independence, in 1523. The blue and yellow are the colours of the Swedish arms, azure, three crowns in pale, or; they were doubtless then taken as the colours of freedom and independence; became well known as such during the Thirty Years' War, and spread even to England, where their memory is still kept up in the blue and yellow cover of the "Edinburgh Review."

I do not know that the Norway flag, as a flag, had any real existence: it is clearly the Danish flag with a blue cross superimposed; for though this is described as blue fimbriated, or bordered with white, the authorized border is too broad, as it is in our own union. The Swedish-Norwegian union, now borne in the upper canton, was devised in 1817, when the two countries were united under one King.

The Russian standard, as well as the ensign, dates from the time of Peter the Great. It bears, not the ordinary two-headed Russian eagle—the eagle which they date back to 1472, when Ivan the Great married Sophia, a niece of Constantine Palæolagus, and assumed the arms of the Greek Empire—but a variation of it specially designed to mark the power of Russia in the adjacent seas; the bird bears in his left claw a chart, supposed to denote the Caspian Sea; in his right, the chart of the Black Sea, and the Sea of Azof; in his left beak, the White Sea; in his right, the Baltic and Gulf of Bothnia. The original ensign seems to have been borrowed from the Dutch, amongst whom, as is familiarly known, the Czar Peter learned the art of ship-building; it was merely the Dutch flag upside down; afterwards, as a further distinction, the white was charged with a small blue St. Andrew's cross, the cross of the Order of St. Andrew, the patron saint of Russia, instituted in 1698; but within a very few years this gave place to the white, with the blue St. Andrew's cross, such as it is now; though during the greater part of the last century, the three squadrons of the Russian Navy, in imitation of the English, wore a white, a blue, or a red ensign, the two latter bearing the blue cross in a white canton.

Greece has adopted the colours of Bavaria, from which she got her first King.

Austria wears the arms of the Dukes of Austria, gules a fess argent, assumed in 1231, as a party badge during civil war.[1] Previous to that, the Austrian flag, the flag which had such a curious relation to English history in the reign of Richard Cœur de Lion, bore the Roman eagle.[2]

Italy wears the tricolour devised for her by Napoleon I, on his declaration of the Kingdom of Italy; it is evidently a modification of the French; though whether the green was a mere whim of the Emperor's, or whether it had some reference to the family colour of Lorraine, intermarried with both Tuscany and Naples, is a point I have not been able to decide; but as no green was ever worn by

[1] For a full discussion of this, see "Monumenta Augustæ Domus Austriacæ;" opera et studio Marquardi Herrgott: vol. i, pp. 63–8.

[2] *Ibid.*, p. 52.

either of these Italian States, I incline to think that it was only fancy. In 1848, the flag, which had long been dead, was assumed by the national party, and was accepted by the King of Sardinia, charged as it now is, with the arms of Savoy, with a border of Piedmontese blue. Of course, with the new birth of the Kingdom of Italy, the flags of the numerous small States have disappeared: all that had any historical interest had disappeared long before; but I cannot pass them by without a brief notice of some that in byegone ages swayed or contested the rule of the Mediterranean.

Venice flew the lion of St. Mark; it seems well established that this was her ensign from the very first, though the colours and details of the design were slightly changed in the course of centuries.

Many of you have probably often wondered how it came about that Genoa wore the old English ensign. The Genoese flag has in fact no relation to the English; I do not think it has even any to St. George. In the year 1284, the Pisans approaching Genoa, shot into the town, as a special insult, a number of stones belted with scarlet. How or why this was a deadly insult, I do not know, but so it was, and could only be washed out with blood. The Genoese mustered their galleys, and to keep the insult they had received fresh in their memory, transferred the scarlet belt to their ensign. The decisive victory which they won at Meloria stamped the flag with the approval of success, and fixed it as their national ensign to their latest independent existence.

The Maltese cross, red on white, or white on red, everybody knows. It was the ensign of the Knights of St. John, whilst their great enemies the Turks wore so many different flags that it would be difficult to mention even half of them; three crescents facing inwards was a favourite device, but worn on red or green fields; striped flags of red, green, and white in different orders, were also worn, both by Turkish ships, and the ships of the semi-independent and wholly piratical States of the north coast of Africa. Tunis, Algiers, Morocco, and the rest of them, are described as having each some three or four different flags, but all with a sort of family likeness, and a predominance of red and green; one, spoken of as an Algerine battle-flag, represents a naked arm waving a falchion, a device borne also in war by the Dutch of the 17th century. The modern Turks have accepted one crescent with a star in white on red, a slight modification of the flags of the last century.

Crossing the Atlantic:—The first flag worn as a national ensign by ships of the United States of America, after their Declaration of Independence, would seem to have been of thirteen horizontal stripes, red and white, and still with the British union in the upper canton; and it is so shown in a contemporary picture, dated July, 1776.[1] But with this, other flags seem to have been worn, either as flags of command, of separate States, or as denoting an exuberant zeal in the cause of liberty and independence. Many of these bear the rattlesnake,

[1] "History of the American Flag," by G. H. Preble: p. 153.

coiled or wavy, with thirteen joints to his tail, and the motto DON'T TREAD ON ME, on a yellow, white, striped red and white, or red and blue ground. Others bear a pine tree, mostly on a white field, with the motto AN APPEAL TO GOD. Some combine the two, and show, on a white field, the rattlesnake coiled round the root of the pine tree, and the two mottoes, above and below.[1] These have often been described as national flags; but a letter from Jay, dated July, 1776, is satisfactory evidence that, at that time, no order had been given by Congress, but that Captains of armed vessels followed their own fancies.

The idea of the rattlesnake was by no means a new one. Five-and-twenty years before, the *Pennsylvania Gazette*, in commenting on the iniquity of the British Government in sending convicts to America, had suggested sending to England in return "a cargo of rattlesnakes, "which should be distributed in St. James's Park, Spring Gardens, "and other places of pleasure, and particularly in noblemen's gardens;" and in 1754–5, during the war against the French and Indians, the same paper adopted as a device a snake cut into eight parts, and the motto JOIN OR DIE. A similar device again came up in 1775, and was the undoubted origin of the rattlesnake flags, which, however, never met with any official sanction.

For nearly a year after the Declaration of Independence no national flag was determined on; neither the rattlesnake nor the pine tree was ever considered as such; and during that year the ships of the United States continued to wear as an ensign the red and white striped flag, plain, or with the British union in the upper canton. It was not till the 14th June, 1777, that it was resolved by Congress, "That the "flag of the thirteen United States be thirteen stripes, alternate red "and white; that the union be thirteen stars, white in a blue field, "representing a new constellation."

The origin of the stars and stripes has been often discussed, and, as far as I know, with no result altogether satisfactory. The theory that they were suggested by the arms of Washington has no sufficient support; neither indeed do these arms—argent, two bars gules; in chief, three mullets of the second—seem to me to present any such striking resemblance to the flag as ordered by Congress. The fact is, that the stripes were no new idea. The picture of 1588, to which I have already referred, as showing an English ship with the royal arms on a striped flag at the main, shows her with also a striped ensign—three horizontal red stripes crossed by one vertical; and the East India Company, from the very first, adopted a striped flag, with first the St. George's cross, and afterwards the union in the upper canton, as in the national ensigns. Such a flag was in use all through last century, and down to 1833; and its use, if only as an Indian flag, must have been familiar to many of the American colonists. But a plain striped flag was also, at the time, a well-known and honourable signal of the British Navy; it was the signal for the red division to draw into line of battle. As to the union, the blue field

[1] "History of the American Flag," by G. H. Preble: p. 143.

was left unchanged, and the idea of substituting thirteen white stars for the two crosses scarcely required to be brought from afar.[1]

For several years after the Peace of 1783, the custom prevailed of adding a star and a stripe for every new State received into the Union. This naturally led to confusion and irregularity; so that on the 18th April, 1818, it was decreed that the number of stripes should be fixed at thirteen, but that there should be a star for every State of the Union. There were then twenty; there are now, I think, thirty-seven, or perhaps a few more. No law has determined how these stars should be placed; and though in the flags of ships of war they are now always ranged in parallel lines, in merchant or private ships fancy runs riot as to the pattern.

The United States Navy, as at first constituted, had no rank higher than that of Commodore; it was not till January, 1857, that Flag Officers were appointed, nor till May, 1858, that these were authorized to wear a plain blue square flag; those whose commissions as Captains dated back more than twenty years, at the fore; all others at the mizen. In September, 1859, this was again modified by a direction to the senior Flag Officer to wear his flag at the main. In March, 1861, it was ordered that when several Flag Officers should be in company, the senior should wear the blue flag, the second a red flag, the third, and others, a white. In July, 1862, the title of Flag Officers was changed to that of Rear-Admirals, the three senior to wear the flag at the main, the next three at the fore, and all others at the mizen; but though this was a virtual appointment of both Admirals and Vice-Admirals, it was not till December, 1864, that the latter title was introduced, nor was the former till July, 1866, and then only, in each case, as a special recognition of the services of Admiral Farragut. The Admirals' flags were blue, with the distinction of four, three, or two stars; but in 1870 these were changed, and the flag for all was ordered to be red and white striped: Commodores to wear a red and white broad pennant, and senior Officers one less broad. The changes in these respects have lately been so frequent that it is difficult to say, with any feeling of certainty, what is now the rule; but I believe the regulation of 1870 still holds.

As closely related to the flag of the United States, I must mention also that of the Confederate States, which endeavoured to secede from them. Short-lived as they were in their independence, their flag was changed three times; at first, with an apparent reluctance to depart widely from the old established form, they fixed it as red, white, red, in three equal bands—the same, in fact, as the Austrian—having a blue square canton coming down to the bottom of the white and charged with nine white stars. In 1863, however, they substituted for this a white flag, having a red canton, bearing a blue saltire edged with white and charged with seventeen white stars; and the following year, 1864, the fly for one-third of the whole length of the flag was made red.

It is scarcely necessary to speak of the numerous flags of Central

[1] The question has been discussed at great length by Captain Preble (pp. 181 *et seq.*), but he arrives at no positive conclusion.

or South America; as far as I know, they are mere fancy flags with little or no meaning, certainly with none which it would be worth our while to inquire into. Brazil alone claims a partial exception: she bears amongst many other devices, and very many other colours, the globe, the armillary sphere of Portugal: otherwise her flag is a model of ugliness, a combination of colours that sets one's teeth on edge: gaudy and Chinese like, wrote the unfortunate Maximilian of Mexico, when it is new; the colour of a rotten egg when it is old.[1]

The Chinese till lately were in somewhat the same condition with regard to flags that European kingdoms were 600 or 700 years ago; every chief or leader had his own, though as a national badge the dragon seems to have been generally accepted. Quite lately it has been distinctly recognized as such; and a yellow flag with a blue, green, and red dragon or devil, sets the canons of European art at defiance.

Beyond China is Japan, the land of the Far East, the source of the sun, as her name signifies; and her Government, interpreting the idea, have given her as a flag the emblem of the glorious orb of day, the sun rising blood red.

I have left myself but little space to speak of the use and custom of flags beyond their direct signification of nationality. And, indeed, as this part of the subject would lead me into a history of signals, foreign to my present purpose, I may properly enough cut it very short.

And, first, in the respect due to national flags. I speak not here of salutes, of the respect which one flag pays to another according to instructions officially and exactly laid down, the history of which, as far as we English are concerned, is itself an embodiment of much of our naval annals.[2] But independently of this, there are traditional ways of showing respect or disrespect, about which a few words may be said. For a ship to hoist the flag of another nation underneath her own has always been considered as a signal of victory in time of battle, or as a mark of gross disrespect or insult in time of peace. When a ship is captured as by boarding, the hoisting her ensign under that of her captors is the direct way of announcing the capture. In the celebrated capture of the "Chesapeake," on the 1st June, 1813, an unfortunate mistake, "owing," says James, "to the halliards being "tangled,"[3] led to the American flag being bent on over the English instead of below it. When the "Shannon's" people observed the American flag going up first, they concluded, of course, that their boarding party had been overpowered, and at once reopened their fire, by which their First Lieutenant and four or five of their own men were killed. Before the flags had got halfway to the mizen peak the mistake was found out, and they were hauled down and hoisted properly. Formerly, when, as I have said, ensigns were not worn at

[1] "Recollections of my Life," vol. iii, p. 161.

[2] I may here refer to a paper on "The Sovereignty of the Sea," in the *Fortnightly Review*, August, 1866.

[3] Vol. vi, p. 59.

the mizen-peak, but at a flag-staff, the signal of victory was to trail the conquered ensign from the taffrail. So also with galleys. Here is one instance, recorded by M. Jal.[1] After a fierce battle between the galleys of France and Spain, off Genoa, on 1st September, 1638, the French victors made a triumphal entry into Marseilles, "towing the "five captured galleys, with their standards, banners, and ensigns trail-"ing in the sea: a humiliation inflicted on the vanquished according "to ancient usage."

In time of peace it is well understood that the flag of a friendly nation may not be hoisted underneath another; and the rigour of this etiquette has given rise to the rule that national flags are not to be used for decoration, or in dressing ship, except with special intent, as mast-head flags. This may be considered as a positive rule, though there is not, I believe, any order on the subject. But the want of its strict observance has in past years led to unpleasantnesses and difficulties. This is one instance. On the 23rd April, 1819, the English frigate "Euryalus," lying at St. Thomas, in the West Indies, had dressed ship in honour of St. George's Day, the fête of the Prince Regent, and in doing so had made use of the blue, white, and red flag, which, four years before, had been the national flag of France. A three-coloured pennant hung down from the spanker boom and trailed in the water; another three-coloured flag was at the lower end of the line pendant from the flying boom. The French Rear-Admiral, Duperré, who was also there in the "Glòire," demanded and received apologies for what he conceived to be an insult offered to a flag which had lately been the flag of France, and under which he and many of his Officers and men had served.[2]

Here is another instance which caused some stir in its time, now nearly forty years ago, and which has been a good deal talked of since. On the 7th of September, 1839, the French sloop "Isère," then lying at Port Louis, in Mauritius, dressed ship, and principally with flags of other nations; it was thus described by an eye-witness, the Captain of a merchant ship in the roadstead, whose testimony was afterwards officially required:—

"Underneath the French flag, on one line, was hoisted, first the American, "secondly, flags of different nations, of which I cannot recollect the names. On the "other halliards were hoisted, in conjunction with other flags, the British colours; "but lowest of them all, St. George's ensign, scarcely clear of the taffrail."

It is impossible to attribute this action of the French Captain to anything but vulgar and even cowardly bounce; for his ship was not seen from the shore, there was no man-of-war in the roadstead, and he could not anticipate any opposition from the merchant ships. It happened, however, that one of these, the "Greenlaw," was commanded by a half-pay master in the Navy, Mr. Thomas Driver, an uncouth old sea dog, more jealous for the respect due to his flag than apt in the minor courtesies of society, a man trained up in one at least of Nelson's maxims,—"There is no way of dealing with a

[1] "Abraham Duquesne," vol. i, p. 83.

[2] Jal: "La Marine" in "Le Moyen Age et la Renaissance;" par P. Lacroix.

"Frenchman but to knock him down. To be civil to them is only to "be laughed at when they are enemies."[1]

Captain Driver had not the force to carry out this advice to the letter; what he did was to get, apparently made for the purpose, a French flag, and the next morning (a Sunday) at eight o'clock, to stop it on, as it is described by a euphemism, "under the bowsprit." As soon as this was observed, a French boat came alongside, and ordered him to take the flag down. This he refused to do, and, as far as I know, the flag stayed there all day, but at any rate, for several hours.

The next morning, two French Officers went on board the "Greenlaw" to demand personal satisfaction. Mr. Driver replied that he was not going to fight subordinates, but was quite ready to meet their Captain. This offer, however, the French Captain declined, and preferred a complaint to the Governor, who called on Mr. Driver to apologize—a thing he was very unwilling to do, and which was urged on him by the Colonial Secretary, in the following letter:—

"Your conduct in offering a deliberate and gross insult on the French flag having "been brought to the notice of the Governor, as well as the grounds upon which you "have attempted to justify it, his Excellency feels it incumbent on him to make the "following observations on the matter.

"It cannot be admitted that every individual subject in a British colony has a "right to take upon himself to resent what he may consider to be an offence to the "national honour, which is there placed in the keeping of the representative of the "Sovereign; and your duty in the present case, therefore, obviously was to have "made a representation on Saturday, directly or through the proper local officer (the "Harbour Master) when it appeared to you that an insult had been offered to the "British flag by the manner in which the national ensigns were displayed on board "the French ship of war 'Isère.'

"If on enquiry your complaint had been found to be substantiated, the Governor "would have lost no time in calling for explanation, and for such reparation as the "case required. But, by adopting the course you have done, this reparation, sup- "posing it to be due, can neither be demanded nor obtained, unless proper amends "be made by you for the more offensive act on the British side; and which, being, "in his Excellency's opinion, most unquestionably due, he calls upon you, in the "Queen's name, to make such further reparation as your offence requires.

"His Excellency takes the honour of the British flag under his own charge in "regard to the position in which it was hoisted on board the 'Isère'; and, if fully "corroborated, he will require, and feels assured that he will obtain, just reparation "for the disrespect so shown to it. But what he directs me to call for from you is "an acknowledgment that you will abide by the decision which the Governor may "adopt in this matter, and that you will fulfil the conditions of it fairly and fully. "From any British subject his Excellency considers that he would have a right to "call for this act of confidence; but as an Officer in the Naval Service of Her "Majesty, he thinks that you are specially bound to accord it, and to leave the "adjustment of this unfortunate occurrence entirely in his hands."[2]

This, after some further correspondence to the same effect, Captain Driver did; and so, so far as was made public, the affair ended. But the Admiralty no doubt thought it prudent to prevent the possibility of any repetition of the act, on one side or the other; and, for many years afterwards, Mauritius was seldom left without a ship of war in the roadstead, literally, in this instance, to protect the flag.

[1] "Despatches, &c.," vol. iii, p. 433.
[2] "Nautical Magazine," 1840, p. 49.

To hoist false colours in time of war has always been considered allowable as a stratagem, in order to entice an enemy within reach; but in no case is it allowed to engage under such, or to commit any hostile act under their shelter; though there are on record instances, clever indeed, almost ludicrous, which can only be described as sailing uncommonly near the wind. One such is the adventure of the "Sybille" and "Fox," at Manilla, on the 13th January, 1798, for the details of which I must refer you to James.[1] I believe it is laid down as a rule that it is legitimate to deceive, but not to cheat. The difference between the two is one that a man of honour will understand, though a lawyer might find a difficulty in defining it. Here is one instance, which will speak for itself. On the 22nd of January, 1783, the French 36-gun frigate "Sybille" was sighted off Cape Henry, by the "Hussar," of 28 guns. The "Sybille," having had, a few days before, a drawn fight with the "Magicienne" (36), had afterwards, in consequence of the damage she had received, been dismasted in a puff of wind, and was now under very make-shift jury-masts. As she was unable to chase the weaker enemy, she appears to have thought it desirable to entice her alongside, and to carry her by boarding. She accordingly hoisted at the peak the French ensign under the English, and in her main shrouds an English ensign reversed and tied in a weft, which then, as now, was a very well understood signal of distress. The "Hussar" was, of course, led to suppose that the ship, evidently French, had been captured by some friend, and, with a small prize crew on board, was in pressing need of assistance. She closed, but fortunately with her men at quarters; for the "Sybille," hauling down the English flag at the peak, and hoisting the French alone, endeavoured to run her on board. Her extreme rolling, however, steadied by no sufficient sail, exposed her bottom fearfully, and several shot from the "Hussar" went through her very bilge; at the same time the 50-gun ship "Centurion" came up, and the "Sybille" struck her flag, this time for good. The weft in the main shrouds remained where it was. The English Officer who took possession of the prize desired her Captain to go on board the "Hussar;" which he did, and on her quarter-deck presented his sword to Captain Russell. Russell took the sword, broke it across, threw it on the deck, sent the Frenchman below, under close confinement in the hold, and so kept him until his arrival in port some days later;[2] considering, and I think properly, that the attempt to entice an enemy into an ambuscade by means of a signal of distress was at once dishonourable and unseamanlike.

The signal of distress made on this occasion was indeed redoubled; for a weft in the shrouds has long been so considered by all nations,—an appeal to a common humanity; whilst the reversal of the ensign, though generally understood, is either not possible or not sufficiently distinct, except for those which have a jack in the upper canton—the English, German, Swedish or Norwegian, and American. On the 14th April, 1857, when the "Raleigh" frigate ran into Macao

[1] Vol. ii, pp. 237, *et seq.*

[2] Beatson's "Memoirs," vol. vi, p. 349.

roadstead in a sinking condition, she first gracefully saluted the Portuguese flag, and then hoisted her ensign reversed, firing at the same time minute guns. No other ship of war was present, and her signal of distress was not understood by the people on the shore; it was only as she got near enough in for them to see how deep she was in the water that they suspected the state of the case. I was myself at Hong Kong at the time, and remember that it was the common talk there that the Portuguese would have understood the ensign half-mast, as a signal of distress; but this could have only been the idea of landsmen; for, among sailors, the ensign so hoisted has never been considered as anything but an emblem of grief or mourning.

Formerly, and from the very earliest times, a ship in token of mourning, used literally to put on black; to paint her sides, her masts, and sails, and cover her parti-coloured pavesades. Most of you will recollect the classical tradition of the death of Ægeus; and a similar display continued to be the usage till a comparatively recent date. In 1525, after the Battle of Pavia, the six French galleys which were permitted to carry the captive Francis and his suite to Barcelona were black from truck to water-line—masts, sails, oars, flags, everything. Later on ships were draped in black, so as to cover the carving and gilding on their stern, their bright-coloured port-lids, and gaudy pavesades. Now that port-lids are painted black, that a ship's side is plain in black and white, and that pavesades have been replaced by white hammocks, or black hammock-cloths, such display of woe is difficult, and indeed, with our modern grim-looking ironclads, impossible. The black flag, with or without the death's head and cross-bones, has been long handed over to the pirates of Madagascar or romance; and the only recognised emblems of mourning are the ensign and pennant at half-mast, and the yards a-cock-bill.

In contradistinction to the black, the white flag might seem to be a mark of gladness; but, in modern times at least, it has never been so considered. It is, as is well known, the flag of truce, the signal to an enemy of a desire to hold communication. So used on board a ship, it is advisable, and I believe customary, to hoist also the national flag of the enemy; as, for instance the white flag at the main, the enemy's ensign at the fore: it was so worn during the last Russian War.

This practice of hoisting the enemy's ensign probably grew up during our wars with France in the end of the seventeenth and during the eighteenth century. As the French ensign was plain white, between it and the flag of truce there was absolutely no difference; and an English ship bearing a flag of truce, of necessity flew the French ensign. On the other hand, at the mast-head of a French ship a plain white flag had no peaceful signification.

Between England and France, the enemy's flag thus came to be understood as, by itself, a flag of truce. Other nations, however, would not so consider it, and the use led to difficulties and unpleasantnesses, of which this is one instance:—

In 1813, whilst the "Jaseur" brig was cruising off the mouth of the Delaware, her Captain, Watts, had occasion to communicate with

the shore relative to the disposition of some prisoners. He accordingly sent the First Lieutenant, in a boat bearing a flag of truce, into Lewes, a small station within the entrance of the river. The boat's crew were enticed away; the Lieutenant was mobbed and insulted, and, with one man only, made a difficult voyage back to the ship, bringing "an "impudent and illiterate letter from the American commandant, com- "menting upon the informality of the flag of truce, and interdicting "any further intercourse of a similar nature."[1] In reply to this, Captain Watts wrote:—

"I have to observe that it is conformable with long established usage, and there- "fore consistent with the law of nations, to display the flags of the two belligerents, "instead of the white flag, with this difference: that it is considered as a point of "complimentary etiquette, a thing apparently but little estimated in the vicinity of "the Delaware. After the reception my Officer, bearing a flag of truce, met with "yesterday, you need be under no apprehension that a 'second attempt' will be "made on my part to communicate with the town of Lewes. When the Govern- "ment of the United States shall have agents endowed with sufficient energy and "invested with competent authority to restrain a despicable mob from insulting a "solitary individual in the exercise of an office which sanctifies his person in the "eyes of a civilised enemy,—then, and not till then, can any amicable intercourse "subsist between us."

The "Jaseur" shortly after left the station; but in now looking back on the circumstances, it seems to me that the fault or mistake was almost altogether on the side of Captain Watts: for, in the first place, such a flag of truce, however it might be understood between English and French, has never been generally recognized; and, in the second, it is contrary to all rule to send a flag of truce into any place where there is no competent Officer to receive it. That there was not in this place, may be assumed from the description of the so-called Governor's letter.

And now, before I finish this necessarily imperfect essay, I want to start an idea which many of you may think wildly heterodox. I have told you how the individual flag, and the ship's flag, and the merely local flag have given place to the national flag; so that a ship of war now, as for centuries past, flies merely her country's ensign, and the official pennant or flag of command. I am by no means sure that a uniformity so rigid is an unmixed advantage; a regiment on shore has, in addition to the national flag, or Queen's colours, its own peculiar flag, the regimental colours, on which are inscribed the names of the regiment's distinguished services. The official list of the Army is itself an epitome of military history, a short chronicle of military achievement. Could not the Navy List be the same for our own service? Could not each ship have, in addition to her ensign, a flag of her own, recalling the glories of her name? Let me give a special instance to illustrate my meaning. Five-and-twenty years ago I had the honour of serving on board the "Royal "George." I do not think I am exaggerating when I say that, with the exception, perhaps, of our Captain, the late Sir Henry Codrington, there was not an Officer or man on board who had a clear idea of any one event that attaches itself in our naval annals to the name of "Royal George," or any idea at all, beyond a hazy recollection of some

[1] Marshall's "Naval Biography." Supplement, Part III (vol. vii), p. 293.

child's story of the "Royal George" going down at Spithead. Yet there are few ships in the Navy that have more brilliant or important antecedents. The "Royal George" was Hawke's flag-ship in Quiberon Bay. She was with Rodney at the relief of Gibraltar in 1780, and again with Darby in 1781. She would have been in the third relieving force under Howe, in 1782, had she not foundered whilst getting ready for sea. She carried Sir Alexander Hood's flag on the 1st of June, 1794; again, off the Isle Groix, in 1795; and, as should be sadly remembered, it was on board her, still Lord Bridport's flag-ship, that the mutiny at Spithead broke out in 1797.

I have taken the "Royal George," merely by reason of the accident of my personal association with her; but there are many other ships with antecedents such as would form a worthy scroll. Here, for instance, are some of the names which might be emblazoned on the "Victory's" flag:—The Spanish Armada, July, 1588; the Downs, 29th November, 1652; Lowestoft, 29th July, 1653; Barfleur, 19th May, 1692; Toulon, August, 1793; Hyères, 13th July, 1795; St. Vincent, 14th February, 1797; Trafalgar, 21st October, 1805. I know that to many, the "Victory" is the ship that bore Nelson's flag at Trafalgar, and nothing more; I see no reason why she should not be equally the ship that was commanded by Hawkins in the summer of 1588.

If such an idea as this that I now suggest could be carried out, I think it would have many advantages, though some of them may perhaps seem fanciful. I think that those who act as name-givers to our new ships would have a certain restraint put on the vagaries in which they are apt to indulge. It might not prevent their naming a ship as a mere passing compliment, "Victor Emmanuel," or "Sultan," or "Shah," but it would probably prevent the confusion which has existed in their minds between honourable names, such as "Emerald," or "Amethyst," or "Topaze," and utterly unmeaning ones, such as "Opal," or "Tourmaline." I think that it would prevent names, such as the "Monmouth," the "Foudroyant," the "Formidable," the "Barfleur,"—names distinguished in a glorious past, being suffered to die out; and, what is of far greater importance, I think that it would have a very real value in teaching and continually reminding our seamen, and our young Officers, aye, and our old Officers too, of the grandest traditions of our Service; in egging them on to emulate the great deeds of their forefathers; in confirming them in that grand belief, first distinctly formulated in words a few weeks before Copenhagen, a few years before Trafalgar, that—

> "The meteor flag of England
> "Shall yet terrific burn,
> "Till danger's troubled night depart,
> "And the star of peace return."

In this very material age we are too apt to overlook the force of sentiment, and to measure the strength of a fleet by its iron, or coal, or big guns. It was none of these that brought the past honours to our flag; for myself, I believe that they will play but a secondary part in upholding it.

LECTURE.

Friday, March 7, 1879.

Major-General Sir HENRY C. RAWLINSON, K.C.B., F.R.S., in the Chair.

PERSIA; AND ITS MILITARY RESOURCES.

By Major-General Sir Frederic J. GOLDSMID, C.B., K.C.S.I.

THE subject on which I have been asked to say a few words to-day, and which I had honestly hoped would have been taken up by a more skilled exponent, carries us back to the remote ages of the world. Even Scriptural history, where it deals with Persian conquerors and their armies, includes periods open to archæological investigation at the present hour. The books of Esther, Ezra, Nehemiah, and Daniel in the Old Testament, and of Esdras and Tobit in the Apocrypha, relate to especially interesting annals of ancient Persia. Allusion to such high authority, where made, will be incidental; but it will not be foreign to our purpose to see what is said by classical writers on the army of Xerxes, moving on westward to Thermopylæ, 480 years before the Christian era.

We get at particulars of military divisions and sub-divisions, however round the numbers, and of dress and equipment, from Herodotus. As to the strength of the whole invading force, the Scriptural expression "he shall stir up *all* against the realm of Græcia,"[1] when applied to Xerxes, supports the truth of the figures commonly given at more than five millions. There can be no doubt that the wealth and resources of so powerful a prince were enormous. He himself is described, when riding forth from Sardis, as having immediately behind him a body of 1,000 spearmen, holding their lances with the point upwards. These were followed by 1,000 picked horsemen. Then came the 10,000 footmen called "immortals," because vacancies were filled up in their ranks so soon as created; of these a tenth part carried spears adorned with golden pomegranates, while the spears of the remaining 9,000 were distinguished by pomegranates of silver. After these

[1] The Hebrew word rendered "all" is said to mean "the whole world." Daniel xi, 2.

came 10,000 cavalry. This computation by thousands is Oriental, and perhaps more especially Persian. So in the book of Esdras, it is shown that Darius sent "1,000 horsemen" to accompany Zorobabel and his companions from Babylon to Jerusalem. The head-dress of the infantry soldier was the *tiara*, which seems to me to correspond with the felt cap much worn by the nomads and lower orders almost throughout Persia. It is called by Herodotus κυρβασία and τιάρα; but the first word may possibly mean a lighter cap of *kirbas*, a word which, if "linen" in Arabic, should also be "cotton" in the Sanskrit *kirpás*. The thick felt has neither a military or protective look about it, yet it is far superior in the latter respect to the Turkish fez. About their bodies we read that they wore "tunics with sleeves of "divers colours having upon them iron scales like those of a fish. "Their legs were protected by trousers; and they bore wicker shields "for bucklers; their quivers hanging at their backs; and their arms "being a short spear, a bow of uncommon size, and arrows of reed. "They had likewise daggers suspended from their girdles along their "right thighs."[1] The wicker shield, called γέρρον by the Greeks, was used at Platæa, not merely for purposes of active defence, but as a rampart behind which the arrow was discharged at the enemy in comparative safety, to the sore distress of the Spartans. The process is illustrated in Professor Rawlinson's Herodotus, a note in which interesting work to the effect that the "plain, round-topped cap, "projecting at the top a little over the brows," is recognized in the sculptures at Persepolis, contains the further remark that the weapons there exhibited are the same as indicated by the great Greek historian. The spear is, however, not remarkably short, being little less than the height of the Grecian one, 7 feet; and the bows are only about 3 feet; the quiver is pendent at the back, and the dagger hangs from the girdle at the right side. Trousers are worn, but the figures have no shield like the γέρρον; nor are the warriors clothed in coats of scale armour like the Assyrians.

The same work supplies us with the following quotation:—"Of "all the troops the Persians were adorned with the greatest magni- "ficence, and they were likewise the most valiant. Besides their "arms, &c., &c., they glittered all over with gold, vast quantities of "which they wore about their persons. They were followed by litters "wherein rode their concubines, and by a numerous train of "attendants handsomely dressed. Camels and sumpter beasts carried "their provision apart from that of the other soldiers."

It appears that the Persian horsemen in the army of Xerxes were armed much in the same way as the footmen, excepting that some of the former wore on their heads devices fashioned with the hammer in brass or steel. The Sagartians, who dwelt in the tracts about Shahrud and Eastern Mazandaran, had a contingent of 8,000 horse drawn up with the Persian troops. This people—Aryans, and speaking the Persian language, but not themselves Persians—adopted partly the Persian dress, but only carried a dirk and a lasso, made of thongs plaited together. The latter is no doubt identical with the

[1] Professor Rawlinson's Herodotus: VII, 61.

kamand, used by the hero Rustam of the Shah-námah, also by the ancient Slavonians and Bulgarians, and was a more effective implement than those unacquainted with its objects might suppose. It captured man and horse, or perplexed, where it did not secure its full end. Down to the era of the Macedonian conquest, or B.C. 334, Persian monarchs always fought from their chariots. The charioteer was then, naturally, the most trustworthy of servants.

At Cunaxa—fought nearly 80 years later than Thermopylæ—where the Persians were stated to be in number 900,000, we are told by Xenophon that the "barbarians" had large corslets and cuirasses, and that all donned helmets except Cyrus, who placed himself, attended by 600 horse, in the centre of the battle, without head-gear of any kind. It was the custom for the Persian princes in those days to go to battle with the *tiara* on the head; and this, if no more than the felt or woollen *tiara*, might well appear as nothing in contrast with the Greek helmets. All the horses in Cyrus' army had both frontlets and breastplates, and the riders had Greek swords. There were 150 chariots armed with scythes. Five years ago, in this hall, General Vaughan recalled to us, in a very pleasant paper, how the Greek soldiers were armed at Cunaxa; but, as he says, the ranks of the "Ten Thousand" who made that immortal retreat from Lower Mesopotamia to Trebizond were at least partly composed of a superior class of men. It might not be fair to compare them with the *οἱ πολλοὶ* of Xerxes.

Some sixty years later again, in Alexander's time, the favourite weapon of the Persian was, apparently, the javelin, or *jarid* of modern days. The real meaning of the word is "a branch of palm "stripped of its leaves." There is a province in Algiers which bears the name of *baladu-l-jarid*, from the date-trees with which it abounds, and hence are obtained the long sticks aimed and parried by Oriental horsemen, in accordance with a practice acquired in youth. The game of *jarid-bázi*, or throwing the *jarid*, has from time immemorial been popular in Persia. It is played by horsemen, each armed with a *jarid* some three cubits long. They divide into contending troops, and two or three start off from one side to be pursued by two or three from the other. The pursuer throws the *jarid* at the pursued, who either catches it in his hand, or allows it to fly over him by slipping under his horse's belly. In either case a good eye, presence of mind, sharpness and agility are required. Supposing the missive to strike the person at whom it is aimed, it may break an arm, if, indeed, it do no further mischief; but it is evident that such a weapon, like a foil, may be made a more or less deadly one if required. Turks and Arabs call an expert player at this rough game a *jindi*.

Morier mentions the *key-kaj* (قیقاج) "an exercise that consists in "turning about on the saddle at full speed, and firing backwards upon "a pursuing enemy. This," he says, "the Persians learn from their "childhood, and it gives them great confidence on horseback," and there is evidence that the practice, like throwing the *jarid*, antedates from the classical periods. Virgil, in his Georgics, and Horace, in his Odes, allude apparently to this very custom among the Parthians. We

must presume that the "firing" in the old days applied to the bow, as it did in later years to the obsolete flint musket and matchlock. The uses of the bow and sword, and horsemanship generally, may be considered indispensable elements of approved Persian education, however much the system of instruction in these accomplishments may have degenerated in modern times. But it would be beyond the limits prescribed for the present paper, were I to dwell further on the classical periods. Neither would it be a very simple, if an interesting study, to follow the changes of dress, weapon, and military organization from century to century, in so little changing a country as Persia. We may not attempt it even by dynasties. And yet some of the Sassanian monarchs, such as the first and second Shahpur, Bahram, and Khosru (better known as Sapor, Varanes, and Chosroes), were engaged in wars with the Romans of sufficient importance to deserve the scrutiny of students. In the seventh century of our era, the Mahommedan religion commenced its work, and soon spread all over Persia. At the dawn of the sixteenth century the Safavian kings began to exercise a sovereign power in these parts which attracted the attention of travellers and the outer world, both to the dynasty itself and the region over which they ruled.

Chardin visited Persia on his way to India in 1664, embarking at Hormuz. He returned the following year, and remained till 1670, when a reference to his biography shows him to have been in Paris. In 1671 he left France for Persia again, which he did not finally quit until the end of 1677. The reigning Shah was, in the first instance, Abbas II, but from 1666, Shah Suliman; they were the fifth and sixth in the list of the better known Safavian kings. Writing of the empire as it was two centuries ago, he found its main strength to be in geographical position. In respect of strongholds Persia was open on all sides. Erivan, the Caspian Gates, Lar, and the fortresses about Media and Bactria, had no real protective value; and Kandahar defended one entrance only. Her natural barriers were her best security, such as the sea, the desert, or a mountain range. Turkey alone, of all her neighbours, was to be feared; but she was too much occupied with the Christian Powers to commit any overt aggression on an Eastern rival. Baghdad was, however, a constant source of discord between the Turks and Persians; and this city had fallen into the hands of the former in 1638.

Chardin esteemed the Persians to be naturally brave and warlike; the flower, in fact, of Asiatic people, and founders of the most ancient and extensive empire in the East. Under Abbas the Great (or from 1585 to 1628) the country had made, single-handed, immense territorial progress; but the peace which had ensued upon his death brought in its train the destructive influences of ease and luxury. Abbas himself had been reared in camps, but he caused his children to be brought up in the *andarun*, or seraglio, and no education could be more enervating. For the future Sovereign it was fatally so. Before his reign, there had been no troops paid from the royal treasury, all were maintained by the provinces, in proportion to the wealth, extent, and population of each. Abbas had raised two special corps of his

own, one consisting of 1,200 infantry, armed with muskets (*tufangchis*) —a great innovation where all had erst been cavalry provided with bows and arrows (*tír-andáz*)—the other, formed of *kúlar*, or slaves—a nominal title given to natives of Circassia, Georgia, and certain slave-supplying lands—mounted, carrying firearms, and kept always completed to 10,000 men. There were, moreover, in Chardin's time, the Safavi body-guard of 200 men, a semi-religious band instituted by the Shaikh Safi, or ancestor of the dynasty, in the days of Taimur; and the 600 *jazáiyaris* of Abbas II. Of these, the first were armed with swords, daggers, and hatchets; while the second had firearms.

The State army was quite a separate organization, and was divided into militia, maintained by the governors of provinces, and the regular troops, known as *kúrchis*. A more familiar name for the latter will be *kizil-bash*, or "red-head," which designation is due to the distinctions originally conferred upon them by the Shaikh aforesaid, in the shape of a red velvet cap. Abbas the Great, jealous of their power and influence, reduced their number, ordered their commander to be decapitated, and scattered them in small bodies about the kingdom. Chardin states that some were horsemen, armed with bow and arrow, sword, dagger, lance, and an axe passed through the saddle-girth; a shield was slung at the back, and the head was protected by a casque, with bands of mail to cover the cheek.[1] He adds that muskets were provided to infantry regiments only, but the musketeers were allowed to ride on the line of march. In his opinion, they were the finest troops in Persia, however diminished and crippled by Abbas. Their pay was commuted, as that of the militia, to land grants, and they received crown lands which passed on from father to son, except where the inheritor declined to perform military service.

Under Abbas I, the Persian artillery consisted of 12,000 men, commanded by a *topchi bashi;* but, after the loss of Baghdad, in the reign of his grandson and successor, it fell to a much smaller number. On the death of the commandant, Husain Kuli Khan, in 1655, no one was appointed to fill his place, and the corps became virtually extinct. If the number was ever as high as stated, I do not for an instant believe that each man was a drilled gunner. The mass must rather have been infantry, a certain number only being competent to do artillery service. How the Persian effective army on the death of Abbas the Great was reckoned at 120,000 men, of whom 50,000 were royal and 70,000 provincial troops, no clear explanation is given: yet Chardin was assured that such was the true figure. It is easier to understand the statement that when the second Abbas inspected the forces at his disposal in 1666, he observed that the same men, horses, and weapons passed in review ten or twelve times before him. Both this prince and his son Suliman made some attempt to restore the strength and efficiency of the army, but little progress was made in the right direction; the service continued to deteriorate, and was a poor one, indeed, under the later Safavian monarchs. In those days a state of

[1] See South Kensington Museum Handbook on "Persian Art," under the head "Arms and Armour," pp. 18 to 21.

peace was especially destructive to the *morale* of a soldier. Neither drill, discipline, garrison, or outpost duty was a serious matter, if at all heeded; the Persian *sarbáz* lived in his own house and had, it might be, no more work to perform for the State than to obey a yearly or half-yearly summons to parade with full equipment, and show his weapons to an inspecting officer. As the latter received occasional *douceurs*, it is presumed that he was possessed of some practical power for good or evil. There was also a provincial parade to be attended once in three years. Children of two years were enrolled in the army registers, and received a salary which, though little more than nominal at first, increased from year to year up to the period of effective enlistment. When Chardin was assisting at a review in 1673, a Persian official of high rank said to him that the troops were very well to look at, but worthless for actual warfare; and, in support of the soundness of this opinion, he himself mentions the circumstance that four years later, when he was leaving Persia, less than 1,200 Cossacks were able to lay waste one section of the Caspian Sea coast, remaining occupied for two or three days in the plunder of noted towns.

From Chardin we will turn to new and less known authorities, who flourished respectively in the reigns of Suliman and Shah Husain, rulers also of the Safavi dynasty.

Monsieur Sanson, a missionary from the French King, Louis XIV, to the Court of Persia, writing before the commencement of the eighteenth century, or in about 1685, estimates the Persian army at 150,000 men, exclusive of the garrisons of cities in the interior. The defensive frontier force is disposed as follows:—

12,000	men	in Kandahar, overlooking India.
20,000	,,	Khurasan, watching Balkh and the Tartars.
15,000	,,	Mazandaran and Ghilan, by the Caspian.
12,000	,,	Darband and Shirwán, for the Caucasus.
20,000[1]	,,	Circassia, Georgia, &c.; and the King's Guards.
20,000	,,	Media, for Turkmania and Kurdistan.
12,000	,,	Erivan, towards the Turkish Empire.
12,000[2]	,,	Laristan, for Baghdad.
15,000	,,	Susa, for Arabia.
12,000	men	for the littoral from the Persian Gulf to the Indus.
Total 150,000		

At this time all were provided for out of the demesnes and confiscated estates. Scarcely any, we are told, were foot soldiers, "because they could not support the fatigue of the many deserts and "mountains. Artillery was little used for the same reason: Persian

[1] This figure is not given; but "a great number" stated. The total is, however, 150,000.

[2] Probably Luristan, north of Susa, though it seems unlikely that 27,000 men would be massed so close together. But the same objection applies to the forces in Circassia and the Caucasus, where there would be 32,000, and for the 32,000 also allotted to Media and Erivan.

"towns were neither walled nor fortified; nor could their frontier "posts resist a strong enemy. The King's Guards were always "mounted."

The intelligent Polish Jesuit, Krusinski, an emissary from the Pope (Clement XI), was in Ispahan during the siege of that city by the Afghans in 1722. There were then, he says, some 400 pieces of cannon mounted at several places; but so badly served that, although discharged at least 400 times each, and thus 160,000 shot expended, not 400 Afghans could have been killed by them. "One may judge "of the skill of the Persian engineers," are his quaint words, "by a "question of the *Topchi-báshi*, or great Master of the Ordnance, who, "when the rebels arrived at Gulnabad, asked the English at Ispahan "if there were cannon in Europe that would carry 12 miles; and if "they thought that there were any guns among his that would carry "as far Gulnabad?" Having myself twice visited this village in passing from Ispahan eastward—remembering it more particularly from its historical interest as the scene of the battle which gave Persia temporarily to the Afghans—I can certify to the distance being about equal to that between the Royal United Service Institution and Harrow-on-the-Hill.

History tells us, that from the ruins of the Safavi dynasty of Persian kings arose a great conqueror, in the person of Nadir Shah. This man, however cruel and vindictive, was a soldier and a commander of soldiers, possessed of marvellous qualifications. To him the exigencies of a military profession, strategy, drill, discipline, and duty were stern realities to be acknowledged and practised. If he punished misconduct severely, he could reward special deserts liberally. Unfortunately, however, the terrible selfishness at the root of all his actions forbids the student of his career to admire passages in it which would call for admiration, had the hero been only cast in a different mould.

Of the feats of the Persian army under such a leader, a word or two may be said, where any practical lesson is to be deduced. In about 1729, the Abdali Afghans, who had possessed the city of Herat, under Shah Sultan Husain of Persia, were preparing with 30,000 horse to move upon Mash-had. Nadir Kuli met them with 12,000 horse at three days' march from Herát. The Afghans commenced the battle with a shout and a rush. Nadir kept his men close together, and posted upon a rising ground, played upon the assailants with some small field pieces, which did great execution. He did not suffer his soldiers to discharge their small arms until the enemy was within 30 or 40 yards, when their full fire drove back their assailants, and gave time to reload. The Persians continued to act on the defensive, till they saw their opportunity, and became themselves the aggressors. Contemporary annals confirm the Persian victory; but whether 5,000 Afghans were taken prisoners, and 15,000 killed and wounded, while their conquerors only lost 1,500 men, is a question which we leave to the statistics of round numbers—a study which might be recommended to chroniclers and compilers of Year Books.

In the memoirs of Nadir Shah we find it recorded, that on arrival in

India, and just prior to the engagement in February, 1739, which placed Delhi and its Emperor at his disposal, not one of his whole army was on foot, and even those who followed the camp and trafficked for necessaries to the men, were completely armed and mounted, the number of all amounting to near 160,000. "In the time of action, the "master could not be distinguished from the servant, nor the trades-"men and traffickers belonging to the camp from the common "soldiers, all in general being bold and resolute, and well qualified to "execute the most desperate attempt they could be employed in: there "were also about 6,000 or 7,000 women, who had been taken captives "from the Turks, and in Kandahar, who on a march could not be "distinguished from the soldiers, having a *baráni* over their own "clothes, girt round with a girdle, their faces veiled with a fine cloth, "a shawl folded round their heads in form of a turban, and booted "and armed as the men."[1]

According to Hanway, Nadir's standing forces were computed at 200,000 men. He encouraged them to wear costly trappings, because he thought a soldier fought better when he had something to lose. His regard for the national honour was perhaps greater than his practical wisdom in its defence in the instance of the two Imperial standards. These, we are told, were so large that it required twelve men to move them; but Nadir lengthened the staff, and made them still heavier to prevent their being carried off by the enemy. The flight of his own standard-bearers was evidently not a contingency contemplated; yet they might reasonably seek, on an emergency, to convey their charge to a secure place, if susceptible of transport.

I will ask you for a few moments to examine with me the information on the Persian army as it has been supplied by our writers during the first half of the present century: after which, we will glance at its condition as reported at the present day: we shall then be in a better position to consider Persia itself as a military power. The authorities I have chiefly consulted are Malcolm, Morier, Waring, and Sheil, of whom the first three visited the country, and wrote about it under Fath Ali Shah, the grandfather of the now reigning monarch, Nasrudin.

Sir John Malcolm divides the Persian army into "a considerable "body of irregular horse, furnished by the military tribes of the coun-"try, and commanded by their own chiefs; a numerous irregular "militia, raised and supported by the provinces and principal cities "of the empire, and a corps of infantry and artillery clothed and "disciplined in the European manner. The first are stated to be the "same kind of troops which opposed the Romans," retaining the habits and mode of fighting of their forefathers, only armed with carbines instead of with bows and arrows. Robust and brave, with strong and active horses, they formed a cavalry thoroughly suited to predatory warfare. They were the compulsory contributions of chiefs of tribes; and doubtless to a great extent composed of the material used so freely by Nadir when he could command Kurds, Kajars, Bakh-

[1] Fraser's History of Nadir Shah, London, 1742, pp. 154-155.

tiars, or Afghans by the thousand to attend his person, or prepare his way through invaded countries. Like the *Kurchis* of Abbas the Great, their military service was rewarded by grants of land and liberty of pasture; but pay, food, and forage appear to have been further given during particular periods of active employment. It should be added, however, that without the prospect of plunder, or under some special requisition of their own acknowledged chief, they were somewhat reluctant to come to the front in the cause of the State. The royal body-guard (or *Kúlar* horsemen of Abbas) numbering in Fath Ali Shah's time only from 3,000 to 4,000, was formed of Georgian slaves and the sons of the Persian nobility. Well mounted and well armed, they not only received better pay than their fellow-soldiers from the public treasury, but they had a licence to pilfer and peculate, of which they availed themselves to the full.

The militia, of which the number is said to have exceeded 150,000 men, was composed of men of wandering tribes and inhabitants of cities and villages. Maintained by the province or community to which they belonged, they were liable to be called out when required, receiving at such time pay from the State, but providing their own arms—usually a matchlock, sword, and dagger, and clothing. They obeyed their own officers, but none beside.

As regards infantry and artillery, we read that the army of Agha Muhammad Khan, the uncle and immediate predecessor of Fath Ali Shah, "consisted of regular horse and infantry, and a number of "*zamburaks* or camel-swivels;" but that Fath Ali Shah himself, "with a view of opposing the Russians, and of strengthening his "internal government," had formed a body of regular infantry and artillery amounting to 20,000 men. Part of this new body of troops had been trained in some measure by English Officers, and were specially clothed, armed, and paid by government: we shall revert to them directly.

The pay of the irregular horseman when employed was seldom more than five or six *tumans* per annum, made good by an assignment on the revenue, liable to loss on discount, together with two ass-loads of grain. In those days the *tuman* was about one pound in English money. Under the Safavian kings it had been worth two pounds; it has now dwindled to seven or eight shillings. Few officers received more than 15 or 20 *tumans*, and four or five ass-loads of grain, each ass-load being valued at a *tuman*. The royal body-guard received as much as 20 to 30 *tumans* yearly per man.

Mr. Scott Waring, of the Bengal Civil Service, visited Shiraz from India in 1802. His description of the military force in Persia is rather confusing, and hardly in accordance with Malcolm's; but we may well believe he had not the same facilities of obtaining information. We gather, however, the following noteworthy points. In ordinary warfare cavalry predominated. Infantry were only used for moving against forts. Regiments consisted of 1,000 men, each commanded by a Mimbashi; the men were paid commonly once a-year, sometimes every three months, but they were supplied with most of the necessaries of life, and even lodging, when away from their homes. They

appeared wholly undisciplined, and their drill to be little more than charging, halting, and skirmishing. To gallop at full speed, stop the horse with a sudden jerk, turn round on the saddle and fire at a supposed adversary, was still the great military exercise. In lining out camps, posting sentries and sending out pickets, the Persians imitated the armies of other States; their own camp being always, however, in a circular shape. Of the body-guard of nominal slaves (*ghulám*), Mr. Waring says that they may be in number about 20,000; but that "the flower of this corps is formed into a body of about 4,000, "who are distinguished by the excessive richness of their dress and "the insolence of their behaviour." He notices the surprising length of the Persian marches—40 or 50 miles a-day; on urgent occasions "at the rate of 70 miles for three days together"—without baggage, of course. "The infantry employed at sieges fire off," he tells us, "a piece "of cannon once an hour or so; and as long as they hit the wall, they "are considered to be well qualified for effecting a breach." An instance of their performance at Bushire may be here repeated as illustrative of the period. A salute was to be fired by the Persian infantry there. "As the guns were not shotted, they conceived that "they might discharge them without any danger to the people who "were crowded about them. They fired the guns, and several persons "were killed on the spot."

Morier's two large volumes on Persia, one published in 1812 and the other in 1818, are excellent works of reference, but contain little information on the Persian army in detail. We gather from the pages of the later publication that the members of the British Embassy, on arriving at a station between Tabriz and Tehran in the summer of 1812, were much struck at the sight of a troop of Persian horse artillery "dressed like Europeans, with shaven chins, with English "arms and accoutrements, booted and spurred, riding with long "stirrups, who, headed by an English Officer, had come to salute the "Ambassador as he alighted at the tent door." The fact is that Abbas Mirza, the heir apparent to the throne, in his anxiety to present something like a creditable front to an antagonist from the north, had resolved to introduce among his soldiers European drill and discipline. Knowing that it would be vain to inculcate the necessity of this measure by mere word of mouth and edict, he resolved to illustrate its practicability, and, as far as possible, its advantages by personal example. The Prince himself, according to his own account, adopted a soldier's dress, and was instructed by a Russian in the military exercise, commencing with squads of 20 or 30 men paraded in a back court to avoid general observation. In course of time he made many nobles follow suit, and eventually, having taught themselves, there were some of the number capable of teaching others. But they had not advanced much further than line and file marching, countermarching, wheeling, and the manual and platoon, when a French Embassy from Bonaparte appeared on the scene, and, like the good genius of the fairy tale, provided them with Officers competent to deal with large bodies. An English mission succeeded the French, which offered like means of efficient instruction, and after a period, through

the exertions of Lieutenant Lindsay, of the Madras Army, the Prince found himself possessed of a corps of disciplined artillery in addition to other troops. The story goes that, notwithstanding the large authority vested in the English Commandant by royal mandate, this Officer never could get over the national antipathy to shaving the chin exhibited by all ranks of his men. One day, however, the chance explosion of a powder-horn in the hands of a gunner carried off the better part of the holder's beard, and Lindsay availed himself of the circumstance to gain his end. Thenceforward the shaved chin became an established rule for artillerymen, and it need hardly be stated that at the present day the practice is sufficiently common to be unrestricted to any particular class of Persians. Especially remarkable for the rejection of hirsute adornments other than the moustache, is the specimen of "la jeune Perse," daily to be met with in European cities where the Shah has established a Legation; nor is this modern fashion unbecoming, however opposed to conventional ideas.

Major Christie, of the Bombay army, was the highly distinguished officer who commanded Abbas Mirza's infantry. At this time they were formed into two great divisions, the "Sarbáz," or those who played with their heads, and the "Jánbáz," or those who played with their lives. The first, according to Malcolm, consisted of twelve corps, each 1,000 strong and representing some particular tribe or locality. Thus there were two regiments of Afshars, one of Erivánis, one of Tabrizis, and so forth; all, however, were natives of the Prince's own province of Azarbaijan. The "Jánbáz" were not so well clothed, paid, or disciplined as the "Sarbáz;" their strength was computed at from eight to nine thousand men; they were composed of distinct tribes, and they were immediately attached to the King. Prince Abbas Mirza had, moreover, raised from the military tribes a brigade of cavalry numbering 1,200 men, and a corps of horse artillery strong enough to man 20 field pieces.

Colonel Sheil was our Minister at Tehran from 1842 to 1847 and from 1849 to 1853, and had otherwise acquired great knowledge and experience of the Shah's country and people. He had originally come there as second in command of a detachment sent from India to drill and discipline the Azarbaijan. His note on the local army attached to Lady Sheil's interesting record of her life in Persia, published in 1856, is full of information. He confirms the account given by Malcolm and Morier of the good work done for the Persian Prince Royal by his English officers, and adds the following:—

"Major Christie was a man of considerable military endowments; "he was killed at the battle of Aslanduz in 1812. His able successor "was Major Hart, of the Royal Army. Under the auspices and "indefatigable co-operation of Abbas Mirza, by whom absolute "authority was confided to him, he brought the infantry of Azarbaijan "to a wonderful state of perfection. The artillery was placed under "Lieutenant Lindsay, afterwards Major-General Sir H. Lindsay. "This Officer acquired extraordinary influence in the army, and in "particular among the artillery. He brought this branch of the "forces in Azarbaijan to such a pitch of real working perfection, and

"introduced so complete a system of *esprit de corps*, that to this day "his name is venerated, and traces of his instruction still survive in "the artillery of that province, which even now preserves some "degree of efficiency."

We are now approaching a period to elucidate which no books of reference could assist us better than the personal acquaintance with the subject possessed by our chairman of to-day. The temptation is great to linger over Sir Justin Sheil's note, above mentioned, as well as another by the same hand on the "Kurds and Kurdistan," but all that I can do is to summarise these data in the briefest possible form. Those who wish to learn more fully the late Envoy's experiences should procure the volume entitled "Life and Manners in Persia," the perusal of which, with its appendices, can hardly disappoint the most fastidious inquirer.

Abbas Mirza died in the lifetime of his father; Fath Ali Shah did not long survive him; Muhammad Shah succeeded to the Persian throne; Sir H. Lindsay, afterwards known as Sir Henry Bethune, died; jealousy and mistrust crept into Anglo-Persian relations; French officers replaced the English; Italians and Germans replaced, though not effectually banishing, the French; at the present hour Austrians have, practically, the field in possession, but a Cossack officer has just appeared, and will, probably, introduce the Russian element. Colonel Sheil designates the Azarbaijan half of the 6,000 artillery as "incom- "parably the best corps in the service;" they were "soldierly, active, "workmanlike fellows, who take their guns anywhere." He also praises highly the Tabriz foundry, established with the aid of English artificers, and notices a powder mill in the neighbourhood of the same town, since transferred to Tehran. He rates a nominal 100,000 of regular infantry at no more than 70,000, "armed with flint muskets "and bayonets, chiefly English," of which the greater part were in- efficient. "The men," he says, "are clothed in blue linen jackets, "supplied by the State, under which, in cold weather, their own "clothes are crammed; large white cotton trousers and *lapcheens*, a "sort of soft leather buskin, which laces halfway up the leg, and is "admirably adapted for marching in dry weather, complete their "dress. The Turk soldier wears on his head the ordinary lambskin "cap; the Leks wear brown *nemed* or felt caps. Knapsacks are not "carried in the Persian army; 30 asses per company are the sub- "stitutes for that article. Tents are allowed to the regiments." The regular cavalry, consisting of 500 hussars, he considers "an absurd "useless body;" but the Shah's body-guard of 2,500 irregulars are "well mounted and armed and excellent horsemen." No number is given of the whole irregular cavalry, but it is stated that they are raised almost entirely among the tribes, and that Azarbaijan supplies 6,000.

Colonel Sheil considers the Persian soldier to be "active, energetic, "and robust," with "immense power of enduring fatigue, privation, "and exposure." He recognizes in him much intelligence and a natural aptitude for a military life; contrasts his lively smartness with the sombre apathy of the Turk, and speaks with admiration of his

long marches of 24 or even 40 miles a day, in spite of being half clothed, half fed, and not even half paid. That the failure to pay the *sarbáz* is as well known to the Shah as to the *sarhang*, or lieutenant-colonel, is illustrated by an anecdote of Fath Ali Shah. His Majesty was talking to a foreign minister about the men of some regiments which had elicited the approval of the latter. "Yes, they are ex-"cellent," exclaimed the King, laughing; "and better still, though "they have been three years without a fraction of pay, they never "ask me for arrears." Internal discipline did not exist. On parade it was limited to an effort of some kind, not always successful, to understand and carry out the words of command spoken. The cavalry had lost its ancient repute, since the creation of a *nizam*, or disciplined army, to the prejudice of the tribe system; but, in Colonel Sheil's estimation, it was a match for both Turk and Cossack. There is no doubt that with the chiefs of tribes rested, to a great extent, the supply of good horses, and that the rejection of their services by the Crown would lead the more important Khans to keep their studs at home, or to seek other means of turning to account the possession of high-bred animals. Let us now contemplate the state of the Persian Army at the present day.

Mr. Robert Grant Watson, for some time attached to Her Majesty's Legation at Tehran, and now Secretary of Legation in Sweden, himself once an Officer in Her Majesty's 105th Foot, published in 1866 a history of Persia from the beginning of the 19th century to 1858, which is very valuable as a work of reference. We may accept the following extract as applicable in 1879:—"The military force of the "country consists, in theory, of 100,000 men, infantry, cavalry, and "artillery; the greater proportions of this number being regular "infantry. The cavalry is nearly all irregular, and is in general only "called on for local service under the chief of the particular district "where it is raised. The Shah's body-guard consists of two regiments "of regular cavalry, of about 800 men each, more or less. There "has been lately raised another small troop of body-guards known by "their accoutrements of silver. The irregular cavalry are variously "habited, according to the custom of the country whence they are "drawn. One small company in Kurdistan is clad in mail and "complete armour. There are about 5,000 artillerymen in the Persian "army, and this branch of the service is by no means badly organized. "It is their artillery that gives to the Persians the advantage in their "contests with the Turkman tribes."

Mr. Watson's opinion of the material of the troops is most favourable; but he condemns the prevalent system under which they work. He thinks the men hardy, patient, enduring, frugal, and sufficiently brave. His testimony to their treatment is that of all who have spoken on the subject from personal knowledge. Pay is always kept in arrears, generally for two or three years; and when issued, it is reduced from its legitimate amount by the enactions of distributing officers, from the *sarhang*, or lieutenant-colonel, downwards. The native officers are, as a rule, incapable, and ignorant of military affairs; and the European drill-instructors, whatever their local rank,

have no actual command in the native army. The service is not a popular one, and could not be provided for at all but by compulsory enrolment.

I observe that in the last number of the *Statesman's Year Book* for 1879, the Persian army, according to the official returns of the Minister of War, is composed of 105,500 men, of whom 5,000 form the artillery, 70,000 the infantry, and 30,500 the cavalry, regular and irregular. Of the total of these troops, one-third only is employed on active service. The standing army, on peace footing, is thus reckoned:—

Artillery	1,500	(five batteries).
Infantry	18,000	
Irregular cavalry	10,000	
Regular „	500	
Total	30,000	

If this statement be correct, the reserve would amount to 75,000 men, who remain scattered about in their villages or districts, engaged in agricultural and other pursuits, until required by the State.

Justice is hardly done to Persia by the *Year Book* in its short notice of that country; but no wonder that the theme is less genial than that of European States. In 1875, it tells us, the Shah decreed that the army should in future be levied by conscription instead of by irregular levies, and that a term of service of twelve years should be substituted for the old system of enlistment for life. As before, the organization is by provinces, tribes, and districts, the province furnishing several regiments, the tribe one or two, and the district one battalion only, the chief of the tribe or district from which the men are drawn being selected to command them. Christians, Jews, and "Gabars," or Fire-worshippers, are exempt from military service.

My own experience of Persia has been derived in five successive visits, *i.e.*, from England *viâ* Russia and the Caspian in 1865; from England *viâ* Constantinople, the Black Sea, and Tiflis, in 1867; from England *viâ* Russia again in 1870; from India, passing up to the capital from Bushahr in 1871; from India, landing at Bandar Abbas, and moving thence to Sistan and Mash-had in 1872. Altogether I have been nearly two years within the limits of Persian dominion, a sufficient time to form a tolerably correct estimate of its government and government employés, its priesthood and learned men, its wandering tribes, indigenous peasantry, and soldiery. Of the last mentioned I have perhaps seen as much as of any class. During my stay at the capital the troops were constantly out at drill. I knew and was well known by the Minister of War, commander-in-chief, Italian drill instructors, and others connected with the local army, and during the fifteen months or so that I was posting, marching, or sojourning in the heart of the country or outlying provinces, I was frequently honoured with an escort, sometimes accompanied by a captain or a major, and more than once had my tent pitched or quarters assigned in the neighbourhood of drums, bugle, and fife.

Of the common *sarbáz*, or Persian infantry soldier, I have a high

opinion, and subscribe fully to what has been said of him by Sir Justin Sheil. At the same time it cannot be denied that in the performances of his long marches he has very often a companion, who relieves him during many a weary mile, independently of carrying some baggage and superfluous accoutrements. This companion, wanting in martial exterior, possesses, in the East especially, a patient energy which accomplishes great physical feats. It is at the risk of a smile at the bathos that I name the too-little-valued donkey, without which adjunct no picture of a Persian infantry soldier would be complete. Setting such aid aside, the marching and endurance of the *sarbáz* are wonderful, and though better food might in some respects improve his *physique*, his frugality is such as to account in some measure for his bodily strength. With good Officers and good training he might be made very efficient. If wanting in the discipline we consider in this country essential to the well-being of the service, the fault is that of his superiors, by whom he is ill-commanded, ill-taught, and ever accursed with an evil example. In fact, the moral value of the soldier deteriorates as the social grade improves. I have found it much the same in Turkey; the state of things is perhaps Oriental rather than national. The post of "wakil," or non-commissioned officer, becomes thus the first step to demoralization. Above this person is the "naib," or lieutenant, corresponding with the Turkish "mulázim;" then comes the "sultán," or captain, the Turkish "yuzbashi;" "yáwar," or major, the Turkish "binbashi;" "sarhang," or lieutenant-colonel, the Turkish "káim-makám;" and the "sartip," or colonel, the Turkish "mir-alai;" such are roughly the respective grades which represent our commissioned ranks. I say "roughly" because there are distinctive sub-divisions to some of these, as, for example, first and second "wakil," first and second "naib," first and second "yáwar," and first, second, and third "sartip" (the two higher corresponding with general of division and general of brigade respectively). I should explain that any wholesale condemnation which I may have seemed to bestow on Persian commissioned officers, applies to their relations with the men. In other respects my experience has not always shown them in so unfavourable a light. About thirteen years ago the present Governor of Kirman, when a *Sarhang* commanding his regiment on the Baluch frontier, received me in the capacity of a travelling British Officer in the most kind and cordial manner. He would take no present on parting but something quite trivial in point of value, and he impressed me strongly as an illustration of good material warped and stunted by miserable custom. On the other hand the social status of the Officers is not, as a rule, on an exalted level, nor are their scruples great in turning an occasional penny. I have known one, whom we should call a field officer in a scientific corps, accept as a gratuity for civilities and small services rendered, a sum which, in civilized Europe, would be offered to menials only. He was not individually to blame; the money was honestly earned, and he was obeying the dictates of precedent, and probably the demands of an empty purse and a hungry family.

In January, 1866, I visited the large town of Bam, on the south-eastern frontier of Persia Proper, between Sistan and Bandar Abbas.

Sir Henry Pottinger has described the place in his travels in 1860, and, although nearly four score years have passed since the date of that description, it is pretty well known that changes in Persian towns are not effected on the same scale as similar changes in our own country. Perhaps no Oriental scholar could find a fitting word for "rashion" in the Persian language, except in the bare sense of manner, habit, and custom. There is no such power acknowledged by them as that which in Western Europe effects a more or less annual modification in dress and society, and influences governments as well as individuals to build or to throw down, to annex or to abandon, to spend money, or to seal up the cash chest. Having already described the condition of Bam, on the occasion of my two visits there, in a paper read at this Institution in 1874, I will not now again go over the same ground; but I may allude to the impression, which I find recorded in a diary of the period, that I had never before seen in any other town of Persia so large a body of comparatively respectable native soldiers. The subject may be followed up by the statement that the most business-like cavalry I can recall in the Shah's dominions were the stray horsemen whom I met with in the Kirman province. Their dress, brown from top to toe, with the κυρβασια of Herodotus and carbine slung over the back, appeared to me simple and soldierlike. It was pleasant to see how the skill and boldness of the rider gave, as it were, new evidence to the exactitude of the Greek historian who, 2,300 years ago, affirmed that riding was one of the three accomplishments taught to the Persians. Nothing but hereditary aptitude could make the horseman so fitted to the horse. Both in 1866 and 1871, but especially in the latter year, I noticed that the Governor of Bampur, in Baluchistan, had good stuff to discipline into irregular cavalry in his mounted Baluchis as well as Persians; and the same remark applies to the Persian Governor of Sistan in 1872. The *istikbal*, or motley troop of cavaliers sent out to meet me by either chief, presented a singular specimen of rough but sufficiently formidable-looking satellites—men who had, clearly, fighting propensities, and might mould, without much effort, into very serviceable soldiers.

Colonel MacGregor, an Officer well known to India for worthy service in the Quartermaster-General's Department, and now prominently engaged in the Afghan expedition, a good soldier, bold traveller, and practical geographer, has just published a narrative of his journey through the north-east of Persia in the year 1875. He found the few irregular cavalry, incidentally brought under his observation in Khurasan, very fairly mounted in a working sense; and the light head-stall, snaffle-bridle, knotted rein, and hair picketing rope with iron chain and peg, used by the men, appeared to him of serviceable kind. He describes precisely the "sort of uncomfortable "imitation of a hussar saddle," with its thick felt pad and felt saddle-cloth, which they affect; and he illustrates, by enumeration of articles, the remark that "over the saddle and behind it they seem to carry all "that belongs to them." The *khurzins*, or saddle-bags, "in which "they put all things," he considers excellent; an opinion endorsed by

many other Oriental travellers. To give reality to the description, he supplies his readers with a faithful drawing of his horseman and horse—the former attired in black lamb's wool cap, long gown and riding boots, whip in hand, and armed with firelock slung across the shoulder—the latter fully equipped, even to silver chains and carpeting, down to its knees and hocks. With less than two pounds a-year in pay, over and above a grain allowance, Colonel MacGregor says truly of these cavaliers, that "if not the best light horsemen in the world, "they are the very cheapest." Nor is it surprising that he does not think them equal to thoroughly trained Indian irregulars. But I am glad to learn that, notwithstanding all shortcomings, he does not write them down "bad fellows;" and, allowing that they "ride very "fairly" and "keep their horses in good working condition," he does not doubt that, if properly treated, they "would prove useful "auxiliaries to our regular cavalry."

His experience of another body belonging to the same service, at an out-of-the-way place between Mash-had and Sarakhs, also merits our notice. Here he tells us that the men were dressed in all sorts of colours, that their horses, of all sizes, were picketed in utter disorder, that they had no orderly lines of regulation tents, and that they were deficient in regimental "necessaries;" but that there was far more uniformity about them than apparent at first sight. "They had all "good serviceable sheepskin busbies, some black, some brown, white "and grey, and nearly all had the sensible movable peak called the "*aftáb gardán* . . . moved round in any direction, so as to afford "shade where the sun beats fiercest." Colonel MacGregor considers the long Persian frock coat to be "one of the most serviceable and "gentlemanly coats" he had seen in any land. Referring to the skill of these Persian irregulars in using matchlocks at full gallop, he cannot regard in a serious light this application of old Parthian tactics to contend with disciplined cavalry,

At Mash-had he saw several Persian regiments encamped outside the city. They were composed of men generally of fine physique, hardy and muscular; but their small pay of seven *tumáns*, not £2 16*s.* per annum, was seldom realized up to half the amount, and they had to subsist chiefly on their rations. Their uniform consisted of a black lamb's wool busby, with a lion and sun in brass on the front, a dark blue tunic, on the European model, with white bands across the breast, blue trousers with red stripe, and shoes (if they like to wear them). They had "clumsy percussion, smooth-bore muskets and bayonets, "with locks of French manufacture;" but they did not clean them, and it was probable that more than half were unfit for actual use. In default of accurate statistics, Colonel MacGregor cannot estimate the strength of the Persian army; though he believes the country could afford to keep up 120,000, and that if this number "were commanded "by European officers, they would be quite a match for the troops of the only power likely to attack them."[1] The artillery, he states to

[1] Narrative of a Journey through the Province of Khorassan and on the N.W., Frontier of Afghanistan, in 1875, by Colonel C. M. MacGregor, C.S.I., C.I.E Bengal Staff Corps, vol. i, p. 298.

be probably the most efficient branch of the service, not smart, but rough and ready. Those whom he noticed on the march to Sarakhs pleased him much by the way in which they handled their guns.

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Discipline, as understood in the Persian Army, has not the meaning which we are here accustomed to attach to the word. It is simply the something which impels a soldier to do a certain amount—not actually his fair amount—of duty, and is produced as much by persuasion akin to bribery as by word of command. Mutiny is not uncommon in hard times, when pay has been too continuously withheld and want has overcome patience; but it is not necessarily treated with severity. The men are talked over; and conciliation and concession win the day when an attempt at violent suppression would fail in its object. How discipline acts with regard to duty among Persian soldiers may be illustrated by a circumstance which came under my own observation. Such of my hearers as may know the story will, I trust, pardon its repetition:—

One night I had crept out of a small bell-tent, pitched in a desolate tract at the foot of the mountain range traversing the Kirman province from east to west, and I was returning thither to sleep, preparatory to an early morning march. A Persian sentry stood just outside the tent with sword ported, and carefully watched my movement. Not caring for such immediate surveillance, and seeing no necessity for keeping the man through the night at his uncomfortable post, I told him he was not wanted. He replied that he dared not go, for he was under orders. Further inquiry elicited the nature of the orders received. They were to the effect that he should remain watching over my personal safety—not all night—but until he had ascertained that I was fairly

asleep. Then he might proceed to his quarters. Trivial as this incident may appear, it is a fair instance of the kind of duty which the Persian soldier is disciplined to fulfil by his own officer. It is eye-service and no more that is required. What wonder that he should be half-hearted in the hour of need, and look to a compromise when required to repel the foe with all his might?

Not many months ago there appeared in the *Journal de St. Pétersbourg* the announcement, from its Tehran correspondent, that the Shah had commenced the "regeneration" of his country. Some people would think that an improvement in the *morale* of government must be an essential part of so vast an undertaking, and that the education, safety, comfort, and well-being of the poorer population must in some measure be provided for in any such contemplated scheme of sweeping reform. But regeneration was in this instance to resolve itself into two great practical results; one the concession to a company of the right to construct a railway from Enzeli to Tehran; the other, the amelioration of the army. How this last result was to be achieved may be partly gathered from the following extract, for which we are indebted to the *Globe*:—

"Austria is sending us a military mission composed of 1 general, 1 "major, 4 captains, and 6 lieutenants and sub-lieutenants. These "officers are on their way to Tehran, and will arrive here in a few "days' time. Orders have just been given for the formation of seven "battalions of Irak, each composed of 800 men, which will give 5,600 "men. As soon as the Austrians arrive they will be sent to Irak, so "carry out the occupation, and to drill the seven battalions, for watch "latter purpose they will remain a twelvemonth at Sultan-Abbad. "At the end of the year they will return to Tehran, to present the "troops to the Shah. It would be a difficult undertaking to organize "5,600 European troops in a year, but it will be more so with the "undisciplined inhabitants of Irak. To prevent their acquiring those "airs of independence which Persian soldiers gain so soon in towns, "the recruits will be confined a year in camp. This will be very dis-"agreeable for the officers, who will encounter no Europeans during "that period."

We are further told that the rifles and cannon purchased by the Shah in Austria will be distributed to the troops on arrival. With the exception of a sensible project of constructing a good road from the Arras to Tabriz, and thence through Zenjan and Kazvin to the capital, there is no minor project of importance to be noted. The introduction of gas and "establishment of other useful public works," are but "talked "of;" and how far the alleged study by the Shah of "a plan of "financial reform and improving the collection of taxes," is likely to aid in the regeneration of his Empire, it is difficult for outsiders to decide. Let us, however, now glance at the measures reported to have been inaugurated for the amelioration of the Persian Army.

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double their Austrian pay. They will be considered as immediately under the Shah's orders, and employed with special troops, who are to be armed, clothed, fed, paid, and quartered in full accordance with their own ideas. A Russian colonel of Cossacks arrived about the same time, and it is reported that other officers, his compatriots, are likely to follow. What are the respective ranks of the Austrian officers I am unable to say, but as the correspondent of the *Journal* is right in his number given, so may he be in this point also. In any case they have a work of much difficulty before them, and will need the constant support of their Minister to carry it to completion. By those Englishmen who have been in Persia, or have studied the subject of its Army, or have heard or read the views and opinions of the drill instructors at Tehran in late years, the general condition of the Persian military service is easily appreciated. The material is good, especially in Azarbaijan and on the West, whether the recruit be Túrk or Kúrd; but it needs true discipline, and fair treatment. Two pounds sixteen shillings per annum for an infantry soldier, and four pounds sixteen shillings for an artilleryman, is the *maximum* of pay, and the daily ration of bread to each is less than three and a half pounds. As bread and fruit are said to be the soldier's ordinary food, we may conclude that more substantial fare is exceptional. In the matter of dress and equipment great reform is needed; and as to drill, having been taught more or less under English, French, Russian, Turkish, and Italian rules, the men require a single and a simple book of instruction. The instruction of officers must be specially provided for. There is some sort of military college in Persia for cadets, but this is wholly insufficient. Appointments to, and promotions in the commissioned ranks will have to be regulated otherwise than at present, where all goes by favour or barter; and the relative positions of officer and soldier will have to be defined in the sense that both are servants of the State, and no private arrangement can be recognized to the prejudice of that connection. To all intents and purposes there is no organized cavalry; bodies of irregulars can be got together by tribes or from provinces; but it might be well to drill and discipline a nucleus of horse for eventual expansion and increase. As to the infantry, attention must be given to a scheme of permanent organization. Divisions and brigades appear now to exist for the purpose of maintaining officers of high rank in sinecures, and many colonels and majors would be puzzled to account for the regiments they are supposed to command. The actual number of each grade borne on the Register is a problem which few could solve; the number of private soldiers is of itself not always, perhaps not often, ascertained. The great question of arms, both for infantry and artillery, has to be thoroughly examined and appreciated. Spasmodic and partial issues of new weapons do not meet the continuous exigiencies of a standing army. Last, but not least in importance, the Reserve to which I have alluded in quoting the *Statesman's Year Book* is, perhaps, rather nominal than real; and there is no corps of Engineers, though there are stray officers called *Muhandis* who seem to belong to one; for I can certify to a pleasant

acquaintance in Baluchistan, so described, on the staff of the Kirman governor.

This is but a very imperfect sketch of a state of affairs to remedy which the Austrian officers will probably be called on to advise and lend their aid. England being, so to speak, out of the coach in this particular matter, has only to look on and observe the progress made by the agents of a friendly Power. A very few words will serve, in conclusion, to wind up the subject which has, I fear, been too discursively (and it may be, too tediously) put before you. These may be found more provocative of discussion than the details which precede them.

Persia is so far important as a military Power and military ally that she has, with all her mis-government and shortcomings, great resources for a powerful army. Let us suppose that the figures put before you in illustration of the nominal strength of her armies during various periods of her history are in many instances exaggerations. We know from the evidence of contemporary annals in the past, and from the statements of our own travellers and writers of the present century or generation, something very near akin to the truth; and that knowledge enables us to form opinions and arrive at conclusions in 1879, on the military value of the country which we have been considering. But any full narrative of the relation between the European Powers and Persia will supply not simply a fair notion of the benefits contemplated in an alliance with the Shah, notably under certain contingencies. It will also demonstrate that England has occupied a very prominent place in courting such alliance, and has lavished so much gold in the prosecution of her aim, that reaction in this respect has seriously affected our interests. I may perhaps venture to affirm that not even in the days of the First Napoleon was Persia more essentially a part of the geographical side of the Eastern Question than she is now, and we need no ghost to tell us that her geography is a matter of political as well as scientific interest to ourselves. As an ally she has the elements of material usefulness, and among her people there is a strange spirit of independence, both in thought and word, which to many minds carries with it proof of power, undeveloped, but no less existent. Were it, however, otherwise, it surely comes within the province of Englishmen to impart to so old a kingdom, and one so replete with classical interest, some of the better things of modern civilization. If not now engaged in training her armies, we may do something to improve her general resources, and strive, though indirectly, to obtain for her masses those advantages which are not withheld from the people in European States. When we did teach her troops their drill, the fate of more than one gallant officer, who died in the performance of his duty, and the substantial service rendered generally by the officers so employed, will testify that Englishmen were loyal to their engagements, and that every profession made on their behalf by our statesmen or diplomatists was fulfilled to the letter.

I presume that, without encroaching too closely upon the domain of politics, I may revert to the presence in Tehran of an officer of

another nationality than Austria, as one of the latest moves of Russia in a favourite quarter. There is no doubt that proximity—or I may say contiguity—has much direct influence upon the Persian mind. A strong, immediate neighbour is dangerous as an enemy; but he may be useful as a friend, especially one who may be grasped by the hand at any time. British India has not the advantage of this position with respect to Persia. If she had, it is probable that the friendship of England would be more practically exercised, and therefore become more intelligible in this part of the East. Mountains and vast tracts now separate the two countries by land. Even the sea route scarcely renders the passage into the interior of Persia an easier matter. From Bandar-Abbas or Bushahr, the road is over high and difficult ranges. There is one spot which, if circumstances ever place it permanently in our possession, would enable us almost to shake hands with our neighbours in Kirman and west of the Helmand. It is the old watch tower of Persia itself towards India; and to which we have already referred in describing the limits of the former country in the 18th century. Situated beyond the lines of lofty and rugged hills, which run more or less parallel to the sea coast from the Indus to the Tigris, it signifies to us a position strategically, politically, and geographically desirable. But I am not here as an advocate, however humble, of annexation. I am merely looking at circumstances which warrant a hypothesis.[1] Recollection of the able lecture[2] so recently given in this theatre on a possible Indo-Afghan frontier will enable you readily to understand that allusion is now made to *Kandahar*.

Colonel PASKE: The Governor of a Persian province is said to have remarked to an English Officer—"There are only two Powers in Asia; Persia, Khiva, Bokhara, "Afghanistan, must in the course of time fall into a state of bondage to one or "other of those Powers." If the march of events has tended to point to the truth of this observation, it seems very desirable that we should acquire all knowledge that is to be possessed of Persia, her resources, and internal affairs. I think then, sir, that Sir Frederic Goldsmid has been very happy in the choice of the subject of his very interesting and instructive lecture. I had myself prepared a few brief notes to read on this occasion, taken mainly from Watson's History of Persia; but as my remarks would be only a repetition of what has been put forward in better form, I will not trespass upon the time of the meeting. Permit me to say briefly that, if the subject of politics were not debarred from discussion in this Institution, a very instructive parallelism might be drawn between the situations of England and Russia with regard to Persia. Certain it seems to be that whichever of the two Powers most speedily acquires a full knowledge of the resources of Persia, and exercises the most beneficial influence upon the government and people of that country, that Power will be paramount in Persia.

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[1] I have said nothing on the feeling with which the Anglo-Afghan War is regarded by Persia; but our whole line of action and successes hitherto have had their effect, and there is no doubt that our prestige and influence *may* rise immensely, if the final result be satisfactory to ourselves. The employment of Austrian officers is rather, perhaps, an accidental consequence of the Shah's late visit to Vienna, than a serious move on the political board; and their task, if ever accomplished, will be beset with more obstacles than those fairly belonging to the mere drill-instructor, however dull his recruits.

[2] "On the Strategical Conditions of our Indian North-West Frontier." By Major-General E. B. Hamley, C.B. *Vide* Journal, No. 98, page 1027 *et seq.*

The CHAIRMAN: Ladies and gentlemen, as no gentleman who has served in Persia, or who has studied the subject of the military resources of that country, wishes to address the meeting, I take the liberty of rising to say a very few words on the subject. Sir Frederic Goldsmid has alluded to my personal acquaintance with Persia, and I am free to admit that at one time I had a considerable acquaintance with the subject, but that is a long time ago. It is now forty-five years since I first went to Persia, where I served for five years in the Shah's army, and of course acquired a good practical acquaintance with the country, and especially with its military resources, which is the subject of this afternoon's lecture. The particular occasion which gave me such a good opportunity of testing the value of the military resources of Persia, was my being deputed to one of the frontier provinces for the purpose of raising three or four infantry regiments from amongst the tribes of the neighbourhood. I had to work *ab initio;* from the first enlisting of the men to forming them into squads, companies, and regiments, and ultimately bringing the brigade up to headquarters to join the army of the Shah. Going through all this practical detail, of course gave me the best opportunity of testing the qualities of the men, and their capacity for military discipline. I cannot speak of their steadiness in the field because we had no severe work to try them; but with regard to their general military adaptability I can say that the impression which I obtained from that frontier service, and from two years of general service with the army, was that there were no people in the world who afforded better rough material for military purposes than the Persians. The physique of the men is admirable, and their power of endurance is great; the absence again of all habits of intemperance is very important, while the general intelligence and personal courage of the men is beyond all praise. It must be remembered that they have never had a fair chance of gaining a military reputation either in former times or in the present day. They have indeed always been at the caprice of interested governors and officers, who looked merely to filling their own pockets, and cared little or nothing for the efficiency of the military force at their command, nor even for the national interest. The army consequently being thus the sport of interested motives, has never emerged, except for a very short time during the employment of Christie and Lindsay, from military mediocrity. But there may perhaps be a future for Persia. If the Persian material, for instance, were placed at the disposal of a European Power who would encourage and take care of the men, and develop their military instincts, a fine working army, very superior, in my opinion, to anything that Turkey could produce, might be obtained in a very short period of time. The tribes indeed on the Western frontier, those inhabiting the range which runs from Ararat to Shiraz, are the very *beau ideal* of military material, the men being athletic, strong, hardy, and active. And with regard to their powers of endurance, a subject to which General Goldsmid has alluded, I may mention that I took the trouble on one occasion to calculate the marches of a Persian army from the road-book of Sergeant Gibbons, one of our non-commissioned officers, who accompanied the force of the Prince Royal, under the command of Captain Shee, of the Madras army, and I found the aggregate of ninety-five marches to give an average of twenty-one miles for the daily march, including the ordinary halts; but excluding the halts at the different large towns where the authorities remained—sometimes for a week or ten days—to arrange government business. This rate of twenty-one miles a-day for ninety-five marches is, I believe, a higher rate of progress than is on record in the history of any European army either of former or present times.

I could go further into details with regard to the organization and discipline of the Persian army, but the subject has been amply treated by the authorities whom General Goldsmid has quoted; and although it may be of interest to military men in certain points of view, it does not at present particularly affect our interests as a nation. I have had occasion more than once in this room to draw attention to the rules excluding all political questions from discussion at the United Service Institution, still we must remember that there are many military subjects which it is almost impossible to examine satisfactorily except in connection with political considerations. In the present instance, for example, the mere abstract question of the military resources of Persia, or the adaptability of the Persian soldier for military purposes, can only be of a very moderate and limited degree of interest; but when we discuss

the question in connection with other political considerations, we then find it to be one which concerns us very nearly. General Goldsmid has already said very truly that from the geographical position of Persia, placed as she is midway between Russian territory on one side and India on the other, it is a necessity that she should become a most important factor in the future political history of the East. It is indeed quite impossible that Persia can remain quiescent, surrounded as she is by nations undergoing the most important political changes. The events which pass in the territories which surround her must necessarily influence Persia herself, and as that influence acts upon the feelings of the country and the Government, so it will re-act upon our interests in India. If, for instance, the military resources of Persia, such as they have been described by Sir Frederic Goldsmid, were placed at the disposal of a Power hostile to England, the country would constitute a most formidable menace to British India; whereas, on the other hand, if Persia were leagued in an honest and cordial alliance with England, and her military resources were strengthened by the material assistance of British money and arms and scientific instruction, then Persia might become an impregnable barrier to India. I will not further pursue the political aspect of the question, but I submit it is in this particular point of view that General Goldsmid's observations to-day have been of so much value. I trust that they have already led in this meeting, and that they will generally lead out of doors to a better appreciation of the value of a Persian alliance, a subject which is at present very little understood, but which is, as I have always fully believed myself, of real importance to the national interests. And I will only add, in conclusion, that, as a well-wisher of Persia, a country with which I have been associated for forty-five years, and the interests of which I have ever had at heart—as a well-wisher of Persia, I say, and more especially as a patriotic Englishman, I do most sincerely trust that the period of suspicion and neglect which has so long prevailed in our relations with Persia, will now be exchanged for one of confidence and active interest. Under such circumstances I believe that a real honest and cordial alliance might be formed between England and Persia, the result of which would be that we should march forward in a common path of peace and progress, of successful commerce, of social improvement, and of advancing civilisation. I beg to be allowed to present the thanks of this meeting to General Goldsmid for his valuable and interesting address.

LECTURE.

Friday, February 14, 1879.

COLONEL C. B. P. NUGENT, C.B., R.E., &c., &c., in the Chair.

MILITARY BALLOONS.

By Captain J. TEMPLER, Royal Middlesex Rifles.

I HAVE been invited to speak a few words to you this afternoon upon the subject of military balloons, and although I could wish that it could have been entrusted to some one more competent to the task of demonstrating the great and important uses to which balloons may be adapted in warfare, I feel that, in the words of the late Prince Consort, "It is the duty of every educated person, as far as in him lies, to add "his humble mite of individual exertion to further the accomplishment "of what he believes Providence to have ordained." The subject is one which has occupied my thoughts for a considerable time, and I think that my observations and experience have thrown some light upon the hindrances and difficulties which have hitherto militated against the practical service of balloons in time of war—difficulties which, I trust, will be eventually reduced to a minimum. It is remarkable that English, French, and American aëronauts of experience and skill have all been of the same opinion as to the immense advantages that would accrue to the Army that could make use of the balloon for military reconnaissances; and General Sir Garnet Wolseley shows, in his admirable work, "The Soldier's Pocket Book," how strongly he feels the importance that balloons might be in reconnoitring. He writes—"One of the most effective means of "learning the whereabouts and doings of an enemy is by means of "balloons; for although the undulations of the ground when viewed "from the car of a balloon at an elevation of about 1,000 or 2,000 feet "do not show, yet the position of troops can be accurately ascertained "in close, still weather. Ascents by night, particularly in wooded "countries, are most useful for this purpose, as the fires indicate the "enemy's position, and his numbers may be roughly estimated by "allowing ten men to each fire. During an action a Staff Officer in "a balloon, at such an elevation, would be of infinite service. The "ascent should be made from some height about a mile in rear of the "skirmishers, a telegraph wire from the car should lead to the spot

"where the General in command had established himself, who could "then be kept acquainted with where the enemy's reserves were "posted."

Though there are divided opinions as to the value of the information derived from the ascents made by the Americans in the war of 1862-3, there is no doubt that an advance in the balloon service was made by them, especially in the successful employment of a portable field gas apparatus for filling the balloons. I quote from a lecture given by Captain Beaumont, of the Royal Engineers, at Chatham, in 1862. He said—"The gas used was hydrogen, and, indeed, for all "practical purposes, all things considered, there is none other that is "nearly so suitable; its low specific gravity makes it a *sine quâ non* "for a military aëronaut as, independently of the ease with which "it is produced, when a balloon is attached to the earth it is of the "first importance that it should offer as little resistance as possible, as "its stability depends upon this point. The hydrogen gas was gene- "rated by using dilute sulphuric acid and iron—any old iron, such as "bits of the tires of wheels, old shot broken up, &c., was used, so that "it was only necessary to provide the sulphuric acid, which in large "quantities is cheap, and with proper precautions, very easy to carry. "There were two sizes of balloons used, one of small size with a "capacity of 13,000 cubic feet, the other of about double the size. "This larger sized balloon was the one the Americans preferred." Captain Beaumont continues, after a description of the balloons, to speak of the Balloon Staff. "With McLellan it consisted of one chief "aëronaut, whose exact rank I never could make out, but it was not "lower than a Captain or higher than a Brigadier. He was a civilian, "and by profession an aëronaut, and he was very highly paid. Under "him was a Captain of Infantry, who had been previously instructed "at West Point (the American Woolwich) in the art of ballooning. "The Captain commanded the men, some 50 in number, and superin- "tended generally every arrangement, including transport. He never "went up himself. Under the Captain was a proportion of non- "commissioned officers, who knew more or less of the management; "and the men, who, besides having a reverential awe of the machine, "knew nothing whatever about it."

Reconnaissances in a difficult wooded and undulating country seem to have been made with success. Captain Beaumont, however, appears doubtful as to the great use of balloons in siege operations, but it is to be remarked that the system was far from perfect. I remarked that the Americans' employment of a portable field gas apparatus was an advance in the right direction; but still it must have been inconveniently heavy to move, and in all details there was room for great improvement.

Military balloons were actually employed so far back as 1794 by the French, as will be seen in the very interesting lecture given on the subject by Captain Grover, R.E.; and there are several other instances of their employment, but they have never been successfully adopted in our own armies.

It will be in the memory of everyone that during the siege of Paris

in the Franco-Prussian War, the Parisians, finding their communications entirely destroyed, had recourse to the balloon for carrying on their postal service, but there had been of course no previous preparation in anticipation of such a contingency.

I will read you a brief extract from Mr. Glaisher's work, "Travels "in the Air," in the preface to the second edition of which he gives a short but an interesting account of their successes and failures. He remarks that—"The need was urgent, there was no time to originate "fresh constructions or introduce new principles. The old invention "as it stood was to be stimulated into success, if success were to be "had. But it was necessary that new balloons should be made, and "at once, for not a balloon in Paris, at the commencement of the "siege, proved, on examination, to be sufficiently trustworthy to pass "over the besieging lines in safety. No pains were spared to avoid "failure, and no detail was thought trifling enough to be overlooked. "Two factories were established, one at the Orleans, and the other "at the Northern Railway Station. The first was placed under the "management of M. Godard, the latter under the direction of "Messrs. Yon and Dartris. Messrs. Godard and Yon are known "in London as having superintended and directed the ascents of "M. Giffard's *Captive* Balloon at Ashburnham Park, Chelsea, in 1869. "Both factories were under the direction of the Post Office. Each of "the two railway stations presented an extraordinary scene. The "balloons, which were constructed to contain about 70,000 cubic feet, "were generally inflated with ordinary gas. The bags of letters and "despatches were firmly fixed outside the car. Higher up was "secured a cage containing carrier pigeons, intended to bring back "news and replies to the outgoing letters."

Sixty-four departures took place between the 23rd of September, 1870, and the 28th of January, 1871, inclusive. On the 7th of October, a balloon, containing 52,800 cubic feet, was sent up from Mont Martre, with Tricket, a cousin of M. Godard, as aëronaut, and M. Gambetta and his nephew as passengers, and 22 lbs. of despatches, and pigeons; and on the 12th of October, another balloon, containing 72,125 cubic feet, carrying 3 men and 600 lbs. of despatches and pigeons. From the list of these balloons furnished in Mr. Glaisher's book, I gather that the failures were of those which ascended under the care of seamen and men who had not been trained to their management and use.

M. Tissandier has published a very interesting history of all these ascents and balloon posts, and has done me the kindness to send me a copy of his work. With reference to this very subject, he says that MM. Eugène Godard, D'Artais, and Yon were commissioned to find aëronauts for the conduct of these balloon posts. Sailors were selected, and of the sixty-four ascents, thirty were directed by these brave fellows. They received a few lessons, but what lessons! A car was suspended to one of the iron girders of the roof of the railway station, to which the pupil climbed, and then called out "let "go"! But it is needless to say that it remained stationary. He was instructed to throw out ballast, and open a valve. Then he let go

the anchor, and went through the forms of descending to earth. A curious apprenticeship, which reminds one of the swimming lessons on dry land!

This report of an eye-witness—of the difficulties attending these Parisian attempts—inevitable as they doubtless were under the circumstances, confirms my opinion, that it would be a fatal mistake to act upon the assumption that any man of spirit and courage was capable of the management of balloons; I am convinced that experience of many ascents, under a competent person, is necessary for the success of travelling balloons. After the first novelty is passed, it seems so perfectly easy that men are apt to overlook the necessary precautions, even if they are thoroughly acquainted with the general rules to be observed. To make ballooning fulfil successfully all its possible duties, a careful education in all branches of its management will be as essential as in any other branch of military service.

Another probable reason, in my opinion, why more success has not been obtained where balloons have been employed, is that there has never been any military corps trained for this branch of the Service.

I believe it to be quite impossible for an aëronaut single-handed to effect any great result in reconnoitring—practically you would, in this case, be sending one man 500 feet high, to do the whole outpost work of an army. He cannot accurately report upon the whole of what he is able actually to see, as you cannot observe correctly when you attempt too wide an expanse of country.

By the employment of three balloons, placed at intervals of two to three miles, with plenty of men who have been previously trained and taught to rely upon one another, I am of opinion that the whole outpost duty of a ten-mile front would be efficiently performed by day, and by making continual ascents at night, the whereabouts and disposition of the enemy's camp would be ascertained by the fires, &c., as Sir Garnet Wolseley suggests.

For the successful navigation of free balloons, it is of the highest importance to ascertain the force and direction of the wind, and how many varying currents and changes of direction there may be. My experience teaches me that you generally find three currents in 5,000 feet elevation. It will then depend on their variance as to where you can take the balloon; it will make this more apparent if I show you on the board the direction of the currents as they actually existed in an ascent I lately made. You may almost liken this course to the moves of certain pieces on the chess board, the bishop advancing and the castles move, illustrating the currents at right angles.

In the first balloon sent up at night from the Northern Railway Station during the siege at Paris, M. Tissandier says the aëronauts were ten hours in the balloon, and descended only a few leagues distant from Paris. They believed that they must have passed over Paris several times during the night, which is quite possible—supposing that they encountered several contrary currents at different altitudes.

My opinion is that these currents might have been utilized for the purpose of delivering the despatches and bringing back replies.

One of the most singular of these voyages was that of M. Rolier,

an engineer, and M. Deshamps, a franc-tireur. They left Paris on the 24th of November at a quarter to eight in the evening, hoping to go towards Tours. The balloon soon attained a height of 2,000 metres beyond the range of the Prussian fire, and it commanded a full view of the whole Prussian camp; then it passed over several towns in the north. Presently the aëronauts thought they heard the noise of a great number of locomotives; they had reached the sea coast, and it was in reality the noise of the waves breaking on the rocks which they could perfectly distinguish. Then they were enveloped in a thick fog, and had no means of determining their aspect or the horizontal movement of the balloon. When the fog dispersed, they found themselves above the sea, and saw a succession of ships. Amongst others a French corvette, to which they made signals, which, doubtless, were not understood, for they were not answered. Their intention was to have allowed themselves to descend into the sea, and to float until they were picked up by the corvette. Later on, they were fired upon, doubtless by a German vessel, but were not touched. They were advancing still to the north with bewildering rapidity. Out of sight of any land, and finding themselves again in a fog, they let fly one of their carrier pigeons announcing that they believed themselves to be lost. They then threw out a long rope from the car which checked their progress, the end of the cord touching the water. At last they perceived land, and threw out a bag of letters and newspapers. The balloon thus lightened rose higher, and took an easterly direction. This was a happy accident; without it, in all probability, the balloon would have gone to the Arctic Sea. Once in this fresh current, the balloon continued its course over terra firma. Losing ballast, it rose to a great height. The valve was opened to let out the gas and descend. At Mar Lifjeld, in Norway, the balloon touched the tree tops. By the help of the rope that the travellers had previously thrown out, they reached the ground almost safe and sound. But relieved of a large portion of the weight, the balloon (naturally) rose with such rapidity that it could not be held. It was then twenty minutes to four in the afternoon of November 25th, Paris time. Fifteen hours had elapsed since their departure from Paris; they were entirely ignorant of what country they had fallen into, and were famished with hunger.

To test the direction the balloon is travelling, and not approving of the celebrated aëronaut Mr. Green's method of working it off a trailing pilot line, I have endeavoured to obtain my direction by other means, and finding no existing instrument that marked the course with sufficient accuracy to satisfy me, Mr. Casella, the eminent instrument maker, constructed for me the instrument I have here, which has answered very well. It may also interest some of my audience to see the anemometer, made also by Mr. Casella, which measures the rates of ascension and descension.

One of the most useful auxiliaries in testing the direction of aircurrents is the small balloon, made of oiled silk, containing about 200 cubic feet of gas, which will mount about 2,000 feet from the large balloon, and is easily discernible at that distance either above or below.

We have made several useful and interesting experiments at Wool-

wich in field gas-making apparatus, field-gasometers, in the manufacture of compressed gas, and receivers for the gas, attachment ropes, car attachment, and in the construction of balloons generally, inclusive of trials for perfecting day and night telegraphic signalling.

I might enter into details of all this work, which, doubtless, would prove of considerable interest; but at this stage it would be neither fair to the Government nor to myself to make such details public.

I will now, therefore, read to you a few extracts from my own log, descriptive of some ascents I have made, with the object of descending at some given place, with a certainty, which I may say, has not before been attained.

Having the advantage of taking the management of one balloon (the "Excelsior") in a double ascent from the Crystal Palace (Mr. Wright commanding the other, a balloon called the "Crystal Palace"), I determined to make my descent at Barnet, as my brother Officers much wanted to see a balloon. Before leaving Barnet I took an observation of the wind by means of the small balloon, and found that there was no direct current; but by remarking the scud flying from the east, and the low current being S.W., I told my brother Officers I would bring the balloon on to the parade-ground at half-past seven that evening; the time of the ascent being six o'clock p.m., and the distance from the Crystal Palace to Barnet being about twenty miles. I may here mention that you ought to be able to give the exact run of a balloon in twenty miles, as if you cannot work it correctly in that distance, the further you go, the more you would be losing the named course. And in naming the place where you mean to descend, you have a very great advantage in having another balloon up, particularly when the aëronaut in charge will obey your directions by signal, as you can make him ascend and take an observation from him, or descend and test the ground or under currents.

Punctually at six, both being ready to start, Mr. Bocock simultaneously slipped the let-go lines of the two balloons, with the last caution to both, to mind the tower, as the wind seemed to set us on it. I, to fulfil my object, made a slow ascent; and at 1,000 feet, finding myself proceeding in a north-westerly direction, I checked the balloon rising further, and took Mr. Wright's direction, and found that he was well to my east, and going to the east of north-east. His elevation was 4,000 feet. This he gave me by disc-signal, Morse code. I quickly saw that I had the advancing bishop's move; I then got out my large field-glasses and had a look for the camp. On crossing the Thames over Westminster Bridge the altitude was 2,000 feet. The formation of our camp at Barnet (a distance of 12 miles) flashed through the glasses. The tents appeared like so many eggs dotted about. I said to my assistant, "I have seen the camp, so we are sure "to get there." I then let the balloon gradually ascend, to make a bit of east, as it is far preferable to go in on the low current, as you have so much less distance to descend.

In passing over London, I had a most magnificent spectacle, and I again obtained the formation of our camp in the field-glasses. I also had a look at Mr. Wright; and, though he had been at one time

5 miles to my east, I found he had lowered into the ground current, and was coming straight towards me, as I was then going on his old course. On passing over the Alexandra Palace, I thought I had better get a little more west, so I let the balloon go just into the top of the under current. I quickly saw that I must again ascend, so I went up again, passing over New Barnet at 4,000 feet. My assistant here could see the camp, and became excited, and begged me to lower, but by the last short run I found that we must tack well over and make a rapid descent into the low current. This we did, and in a few seconds we dropped to 400 feet elevation, and the quick, under current immediately took us over the encampment. I could not drop my anchor, as the men were as thick over the field as so many bees, so I opened my valves and let the pilot-line go, and made my descent in the parade ground, as I had intended.

The remark was made by a witness of the descent, "Ah! that "is all very well, but you cannot do it again." Now, I differed entirely with him, as I think if you can do a thing once, you can do it again. The night previous to an ascent that I was going to make from the Crystal Palace, I promised Captain Lee to take him to Aldershot. The next morning the wind had slackened to 12 miles an hour, and was due east. Now, I knew I must get some north to drive me south, so leaving the Crystal Palace at six, accompanied by Captain Lee and Mr. Apsley Pellatt, Mr. Wright having charge of the other balloon, we both started to find a north current, and it was not until we had attained 5,000 feet altitude that we could get any south at all. Having a pretty good load on board, and not very much ballast, and being a very slow day, and passing over the house of an old friend of mine at Leatherhead, I proposed to Captain Lee to go down. He said, "Yes, "you can go down, but you must come up again, and go on to Alder- "shot, as proposed." I said, "Well, we shall be up all night, for "it seems so slow. However, we will keep on. We are sure to get "there some time or other, for we have the 'castle's move.' We will "go down and have a look at Randall's Park." Randall's Park is a very charming and pretty place, with the Mole running through the park. It looked to me to be a little smaller than one would have imagined, but the first thing that strikes you on a first aspect is the insignificance of the works that man takes so much time to construct. Again, as the altitude increases, so the undulations become a plane, until, at 5,000 feet, England at any rate looks like a vast plane. It is then that it is difficult to distinguish the different towns, but if the course of the balloon has been regularly marked on the chart, the towns, railways, roads, or rivers correct the chart. We now found that it was necessary to assume our old elevation of 5,000 feet, and I told Captain Lee that we should have to descend the whole distance, as we could not make Aldershot.

A most beautiful view of Aldershot from this elevation was seen, and it was a very pretty sight to see it all lighted up. About ten minutes after they had lit all the lamps, I found that the time had come, so throwing out a thousand pieces of paper to accurately get the low current, I opened the large valve and away we went and made a very good descent in the North Camp.

General Sir Thomas Steele came up and told us he had been watching us for an hour and had enjoyed the sight very much. The soldiers ran down by thousands and I let them pack the balloon as they liked, as they were so delighted with it.

This was certainly the hardest trial I ever had, as it was an exceedingly difficult day, the upper current being very slow and not quite reliable.

In order to prove my theories of how useful the alteration of the base departure of the balloon is (the portable field service gas works not being completed), I arranged with the Southall Gas Works for a cargo of gas. I was then enabled to fill at three places ten miles apart, namely at Woolwich Arsenal, at the Crystal Palace, and at Southall. Wishing to descend at Harrow, and finding the wind west, and high current north-west, I decided to fill at Southall; with the desired object of descending in the Cricket Ground at Harrow. Accompanied by Mr. Pellatt, we loosed the "Crusader," and with some little difficulty we descended in the desired spot. Having some long pilot ropes with us, we made many captive ascents up to 400 feet elevation. I then made another short free ascent and then sent Mr. Pellatt away by himself; he eventually took the balloon in at Hatfield. We made several interesting notes on this ascent. I should mention that the rising of the ground does not affect the true direction or elevation of the ground current. Ascending from Woolwich Arsenal, accompanied by Captain Watson and Mr. Pellatt, we quickly ran into a severe storm cloud. As the wind was entirely superseded by the terrific violence of the storm, and I found that it would not be advisable to go above the rain storm, as we were nearly over London, I looked out a nice clear space to come down, and descended at the Bricklayers' Arms Station. The number of roughs overpowered us, and as the station master wished us to get away, I decided to take the balloon away alone. She went up at a good speed, and I thought I would let her go as long and as far as it liked, as it was important to get through the rain cloud. This cloud was the heaviest I had ever seen, about 12,000 feet thick. I found that the balloon came to her natural elevation at 14,000 to 15,000 feet elevation, and there we stayed for three hours and a-half, with a very slow direction anywhere. When the severity of the storm ceased, I had a magnificent view of the surrounding county, and being very wet decided to come down at a friend's house at Watford. I quickly recognised the spot, and descended at Mr. Sedgwick's. The notes on this ascent prove the slowness of the upper current in storms.

I may say that the object we have all thought of the first importance is, to reduce weight as much as possible, secondly, the portability of the field gas-making machines, and the manufacture of gas from wood or any fuel that a foreign country may afford. The furnace must not weigh more than 6 tons complete, and no piece of it more than 5 cwt., and it must be capable of producing 5,000 feet of hydrogen an hour.

From the results obtained from these and many other ascents and experiments, we may confidently conclude that with a properly trained

company of Engineers, the "captive" balloon may be made of immense service to an army for the various duties of outpost work; for reconnoissances; for the survey of surrounding country, of the roads means for an army to march; for the selection of fresh camping grounds and water; for signalling both by day and night; and that the balloon may be used for acquiring information in conveying messages and directions under circumstances when no other means of communication could be adopted.

I have now given you a brief outline of my interesting subject, and it only remains for me to thank you cordially for the kind patience with which you have listened to me this afternoon.

Captain WATSON, R.E., said he had been connected with the experiments made respecting the employment of balloons for military purposes during the last few years. Very considerable progress had been made, and he hoped we should soon have a very good equipment for military purposes. The most important point was to have everything ready in peace time and the men thoroughly trained. If an attempt were made to organize an equipment after war had broken out, it would probably result in failure, and people would say it was the fault of the balloons, whereas it would actually be the result of the men not being properly trained. Practice was requisite, not only to manage the balloon, but also to read the ground; for if a Staff Officer, however good at reconnoitring, were sent up in a balloon, the chances were he would not understand what he saw, the appearance being so very different. For instance, at a height of 2,000 feet, a hill 500 feet high would not be seen at all, except by the shadow it cast over the ground. That was one point upon which they must specially take care to train the Officers and men employed.

Professor ABEL said he had listened with great interest and pleasure to the very modest account given by Captain Templer, of his experience and skill as an æronaut, and having himself had some practical experience, he was glad to bear testimony to the perseverance, the skill, science, and thorough practical knowledge shown by the lecturer in his labours connected with the development of balloon equipment. It was some eighteen or nineteen years since Mr. Abel first made experiments for the Government, with reference to the generation of hydrogen gas, by the method so successfully adopted by Captain Templer, viz., by the action of steam on iron. That method had been known for many years, but Captain Templer had, by simple expedients and arrangements, succeeded in making an operation which was difficult to carry out on a large scale with anything approaching success, as they required an admirably continuous one, he had succeeded in bringing steam so to bear in its action upon the iron as to enable them to utilize practically the whole of the iron, and to obtain, not only at first but continuously, a copious supply of gas. He had also effected a considerable reduction in the weight of the plant which it would be necessary to carry into the field for the inflation of captive balloons of moderate dimensions, and thus one of the chief difficulties connected with their possible extensive employment in connection with military operations, was likely to be removed through the successful labours of Captain Templer.

Captain GILMORE, R.N., asked if the balloon travelled at the same speed as the wind.

Captain TEMPLER: Exactly at the same speed.

Captain GILMORE asked if it was possible to construct a balloon in compartments, so that, in the event of being struck by shot, it might still retain sufficient buoyancy by means of the uninjured compartments. Balloons had been used in the attack on Venice. They were sent up from the side or the deck of the "Silvio," and endeavoured to be brought over Venice, in order to drop shells into the town. Several of the balloons came very nearly over the town, but no damage was done by the shells.

Captain COLOMB said he had been considerably puzzled as to how the instrument for taking the direction of the balloon would work. If the balloon was travelling

with and at the same speed as the current, what action could the wind have in moving the vane?

Captain GILMORE asked if it was possible to influence the course of the balloon, or must they always go before the wind?

SIR HARRY VERNEY inquired how Captain Templer could ascertain the direction of the wind above a certain height. He could quite understand a small balloon being sent up 500 feet, but was it possible to ascertain the direction of the wind at a height of 1,500 or 2,000 feet, until the balloon itself ascends?

Mr. SCOTT RUSSELL said he had been in the habit of looking down on ground-plans of towns, and fields, and countries from heights of 5,000 to 8,000, or 10,000 feet, and could certify all that had been said as to the utterly different appearance they presented to what would have been imagined, judging from their appearance when viewed from below.

Lieut.-Col. BAYLIS, R.V., said great credit was due to Captain Templer for his discoveries. The production of hydrogen by the action of dilute sulphuric acid upon iron filings was known in the last century, but none the less credit was due to Captain Templer, for having put in practice, so as to make useful, that which was known many years ago.

Lieutenant FERRIS, R.N., asked if any information could be given with reference to the balloon guns used against the balloons during the siege of Paris.

Captain LEE, R.E., said his *locus standi* on that occasion consisted in having served an apprenticeship in ballooning to Captain Templer for the last few months, during which time they had made many ascents together. It was not at all the easy thing to work a balloon successfully that most people think. The aëronaut not only required general experience, but also to know the particular balloon in which he was sailing just as a yachtsman must know the peculiarities of his vessel.[1] In sailing a vessel on the sea observations were necessary to determine the speed and course, and in ballooning the man working the balloon had in addition to give, without a moment's hesitation, information as to speed and position in a vertical plane, for any faltering might be productive of serious consequences. Going up from Woolwich they were continually crossing the numerous bends of the river and getting among the creeks of the sea; on the east coast in foggy weather they had to see, at a moment's notice, where they were, and to decide at once upon the best course of operation. The eye must also be constantly kept on the compass, especially in foggy weather, on account of the twisting of the balloon. He once mistook the south bank of the Thames for the north through losing sight of the compass for a minute or two. With regard to free ballooning during the siege of Paris they believed that the partial success attending those operations would have been greatly increased with proper instruction, training, and organization for the men. In fact, he looked forward to the day when an Officer would be able to say to his aëronauts, "I give you two balloons; I shall expect you to go to such-and-such an area, to "deliver despatches and return to the city within such-and-such a time." With proper organization and appliances he should not object to receive such an order, nor refuse to recognise its practicability. As to captive balloons his experience was rather limited, his attention having been chiefly drawn to the production of the gas and the envelope to retain it; but so far as it had gone, it was strongly in favour of erring on the liberal side in the way of buoyancy or size in the balloon. An inadequately buoyant captive balloon in an otherwise than open country was an extremely troublesome customer. There were some matters still under consideration, the principal points being the attachment; that the car should hang free from the hoop without being attached to the rope, that the latter should be provided with a swivel, a strong india-rubber spring and disconnecting gear, for it is obvious that

[1] This particular experience is especially requisite in guarding against and controlling the vagaries of a balloon in a vertical plane; as it is obvious that to have a balloon rushing up and down, as it will do in inexperienced hands, will result in the loss of both gas and ballast. Hence the escape after descent of a balloon (with a passenger) when half empty of gas is to be particularly guarded against, as it has become so rarefied that to attempt to pull the valve has resulted in the collapse of the head of the balloon.

either with or against the will of the observer, the disconnection of the balloon from its captive state must always be foreseen, and the proper appliances and ballast should always be provided for such an eventuality. With these precautions he saw a probable success in the future for military balloons, especially if the system was in duplicate or triplicate, as it should be, so that too much should not be placed on the shoulders of one observer.

Mr. THOMAS MOY suggested the use of asbestos cloth for the construction of balloons, as being an uninflammable material. Instead of using gas at all they might use air heated up to 500° or 600°, which would give great lifting power. That could be provided by means of a small steam engine of very light construction, and the heat from the chimney would inflate the balloon. A vertical screw could be worked by the engine, and so they could get any height they wished, though he did not propose to drive a balloon against the wind.

Captain TEMPLER, in reply, said the speed of the balloon was the same as of the wind. Captain Colomb had asked how the direction instrument would work in such circumstances. They could not make it work if they were to be exactly stationary, but in fact they never were. The instrument went up with them, and the force of going up caught the fan and so helped it to take the direction. Then in a crossing current they got circular motion in the balloon. Sometimes, on a very still day, they had to put a little piece of paper on the breeze fan, so as to give it a little more power, but it would give the direction of the balloon. The balloon would not, as a rule, twist unless it was going from one current into another, and the change of current sometimes might give it a twist. It was then they would lose the points of the compass, and if relying only on that instrument they would want some mark on the ground. Making a balloon in compartments, to secure it against shot and shell, would be useless, because a shot going through the balloon would not hurt it. By going a little higher they would obtain a little more expansion, which would expand through the shot hole instead of through the valve. It had never been ascertained how high a shot could really go, and they contemplated sending up an empty balloon to a height of 800 feet, and then letting a battalion of infantry shoot at it. For that purpose Mr. Casella had made a self-indicating aneroid barometer, the indices of which were so extremely light that it would absolutely mark the highest and lowest point. That would correctly give the height of the balloon. It would probably also be tried at a height of 700 feet, and he much doubted whether it could be hit even at that distance. He should feel himself quite safe at 1,000 feet. They did not propose in actual service to take the balloons into places where they could be reached by shot and shell. The object of ballooning was to know where the enemy were, and if they were fired at, they would be very much obliged, as it would disclose the position of the enemy. It was not possible to influence the course of the balloon; it must go with the wind. They might find a current, and that would influence the balloon, but they could do nothing else. The only plan was to select the right base at starting. He had been asked how the direction of the wind could be obtained above a given height. Captain Watson had a very ingenious device which prevented their lowering paper from the balloon or wasting gas. He had a small balloon holding, say 200 feet, with a small silk cord attached. When they had obtained an elevation of 500 feet the small balloon, with its car full of sand, was suspended below the large balloon; and as they went up and took the high current they could see the divergence of the rope from the balloon below. In the same way, if they wished to test a higher current they would unload the car by a jerk, and let the balloon ascend, say 1,000 feet above them; so that they could get the top current by means of the small balloon as well as the under current. With reference to the siege of Paris, he believed that some shots reached one French balloon; but that was, he expected, only about 100 feet up. Mr. Godard, jun., described the shells as coming up and turning, but he did not say what height he was at. As to the balloon fabric, they had made very many experiments as to the best means of construction, and were very well satisfied with the fabric manufactured especially for them, and which had only been got out with a very great deal of labour.

Mr. MOY said he spoke of asbestos fabric as being fire-proof.

Professor ABEL said asbestos would be far too heavy even in the thinnest condition.

The CHAIRMAN said that Captain Templer had not only brought to perfection many of the instruments exhibited on the table, but the material for the balloon was his own manufacture, the ropes were his own manufacture, and the car was his own manufacture, and that he had shown himself a skilful and resolute äeronant. The French had given much consideration many years to the application of balloons to military purposes. In 1794, the French Army under Jourdan made considerable use of a balloon equipage for purposes of reconnaissance, and owed some of their success near Fleurus to the information thus derived. In the campaign in Egypt, Napoleon had with him an apparatus for reconnoitring balloons, but the English fortunately got hold of the essential portion of it, and no use was made of it. Balloons were also tried at Solferino, but there were very conflicting accounts of the advantage that was derived from them. Reading the history of the American Civil War, they must come to the conclusion that the Americans with all their ingenuity did not derive much advantage from ballooning. No doubt, however, a certain measure of success was achieved during the siege of Paris. From sixty-four to sixty-six balloons were sent out of the city, of which ten fell in neutral ground, two or three went out to sea, five fell into the hands of the enemy, and the remainder more or less reached their destination. They carried 3,000,000 letters, and about 200 people from first to last. They also carried a quantity of pigeons and some dogs; none of the dogs came back and very few of the pigeons. The intention was that the pigeons and dogs should be a return post. He believed that was principally owing to the fact that they had not the proper kind of pigeon. But what they did not succeed in doing was, to get back into the city with balloons. It was not always very easy to make a place from the outside, although Captain Templer had shown to demonstration on the board that he was able to do this, and could descend where he pleased. No doubt a great deal could be done by organization. The War Department did not give so much attention to free ballooning as to captive ballooning. It had portable arrangements for making gas; it had a balloon of a moderate size, and hoped to carry it with them, in the field and to train and equip, not a very large body of men, but a small number who should perform their part (and a very important part if taken up and acted upon with discretion) in warfare. No class of men were so sanguine as inventors, and of all inventors balloon inventors appeared to be the most sanguine, in fact it was a very strange fascination which the science of balloon-äerostation exercised over its followers, and all kinds of inventions, many of them utterly ridiculous were brought forward. He believed that but one satisfactory answer was ever given to an inventor of balloons. An American proposed a large balloon to the War Department and asked a large remittance to start. He was told if he would come over in his balloon the matter would be considered, but he has not arrived yet. They had also heard of balloons which dropped missiles into besieged cities, and on the previous day he had received a letter from a very distinguished Officer, General Sir J. Bisset, pointing out that he was not able to be present, and asking credit for having suggested two or three years back a balloon that should drop a rocket or some analogous composition into the kraals of the Kaffirs. No doubt that suggestion was made by the gallant Officer, but it was also made exactly 200 years ago by a man called Francis Lama. They had derived much pleasure from Captain Templer's interesting paper, and he therefore had much satisfaction in proposing that the thanks of the Institution should be accorded to him.

Evening Meeting.

Monday, February 17, 1879.

REAR-ADMIRAL M. S. NOLLOTH, Member of Council, in the Chair.

EXCESSIVE ROLLING OF SHIPS; ITS CAUSES, CONSEQUENCES, AND CURE.

By Vice-Admiral E. GARDINER FISHBOURNE, C.B.

THIS was always a difficult subject from the number of conflicting elements. It has been made more difficult of comprehension by the circulation of dangerous theories with so much talent that sailors, though these conflicted with all their seafaring experience, have been misled.

The whole question of success or failure in naval architecture, and when the latter, of millions of money and hundreds of lives annually is involved.

Before we can arrive at a satisfactory conclusion, we must ascertain what are the causes of rolling, and what the forms and qualities that tend to limit the number and extent of the arcs of roll.

In a word we must know all the factors in each problem, and measure their respective influences.

Ships, like all bodies under the influence of gravity, when brought to rest, tend to remain so.

Our start-point in discussion must be from the state of rest—rest both of the water and of the vessel it floats.

The equilibrium of water, owing to its fluidity, is easily disturbed, but for the same reason it more immediately returns to equilibrium.

For our purpose we must consider its normal condition to be rest in equilibrium.

Gravity draws the particles towards the earth's centre, but they are supported by those immediately below; but being fluid, they need the lateral support of those around, as the body of water needs the support of the containing vessel.

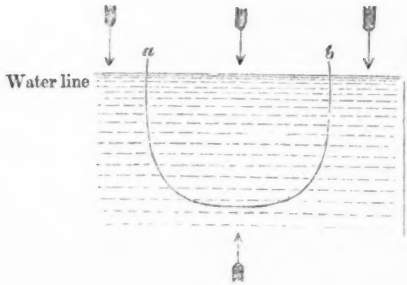
The pressure of the first series of particles is equal to their weight,

that of the second is their weight and that of those immediately above, so on continuously down through each column of particles.

So, if a number of particles are taken out, the superincumbent columns around tend to press out laterally those below, and to press them up to their own level, to fill up the space vacated by those abstracted, and so on till equilibrium is re-established.

Let Fig. 1 represent columns of particles: if a skin, *ab*, be inserted enclosing a quantity, it will bear on its upper surface the collected pressures of the particles above it; but it will be supported by the surrounding columns pressing down, thus producing an upward pressure under the skin.

FIG. 1.



Depth. Feet.	Pressure lbs. on square foot.
1	64
4	256
8	448
12	768
21	1,324
28	1,792

Water being homogeneous, the pressures are uniform and equal at equal depths, so the upward pressures may be considered as if there was but one passing up in a line through the centre of figure, equal to their sum, though these pressures are all actually on the enveloping skin.

The former also is true of the mass of particles above; their pressure may be treated as one passing down through the centre of figure, which is also their centre of gravity.

Let us now suppose a rigid vessel of the same weight and form as the volume of particles within *ab* to be lowered down on *ab*, as it sinks, it will push out these particles, lifting and spreading them out on either side.

This body will sink till it has displaced them all, and will occupy the space, and its skin or outer surface will take all the upward pressures that were on *ab*, and being of the same weight as the particles that were above *ab* will press down with an equal pressure with them.

These two equal and opposite pressures obtain in all floating bodies, but will vary in amount with the dimensions, or immersion, or with the specific gravity of the fluid in which the body floats.

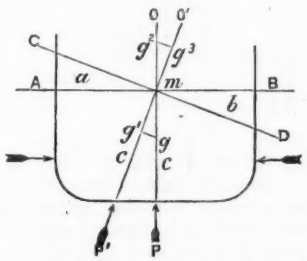
The weights in a ship are not homogeneous, but they may be so distributed as to be referable to a common centre of gravity, so that

one weight, equal to their sum, may be treated as one passing down in a perpendicular through that centre.

When the line passing down through the above centre, and that passing up through the centre of figure, are in the same vertical straight line, these equal forces will be opposite, and the vessel at rest in the upright position, *i.e.*, if the centre of gravity is in the middle line of the vessel and is sufficiently low.

The lines of supporting pressures on the bottoms of ships virtually converge to a *locus* or point.

FIG. 2.



This is not a fixed point, but varies as the vessel is more or less immersed, also with the angle of inclination, and with the form. In a seaway it is radically changed, and continually changing.

If a vessel, as in Fig. 2, be inclined from the perpendicular to AB, the water-line, till CD becomes the water-line, then the original line of support PO will be moved over to P^1O^1. The point of intersection of these two lines at m is the metacentre.

If the centre of gravity be below m, say at g, the weight will act through the lever gg^1 to force the ship back into the upright position.

If, on the contrary, the centre of gravity be raised above m to g^2, then the whole weight, acting through the lever g^2g^3, will force the ship over in search of stability, and will bring it round till g^2 is below m bottom up, till she founders.

Consequently the less the metacentric height (which is the height of metacentre above the centre of gravity of the floating body, measured on the vertical axis) the less will be the force to keep the vessel at rest, or to bring her back to the point of rest when disturbed, the greater also the angle of inclination to which a given force will incline her.

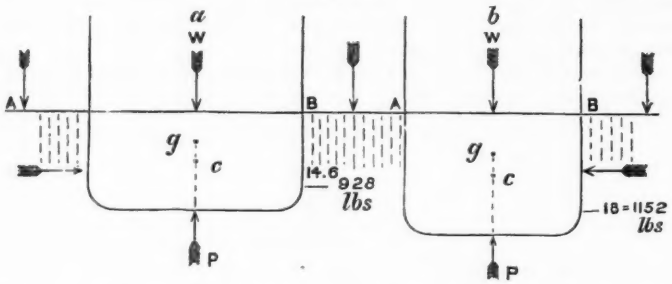
But there are other causes of steadiness to which we must now refer.

We have seen from Fig. 1 how fast the vertical pressures increase with the depth, and how owing to the fluidity of water these press the particles against each other and against the sides and bottoms of vessels immersed in them.

When a vessel is at rest the lateral pressures are equal and opposite, and they steady the vessel in proportion as she is more immersed and her sides approach the vertical.

Suppose Fig. 3 to represent two vessels, *a* and *b*, of equal volume but of different form and immersion. In each, AB is the water-line,

FIG. 3.



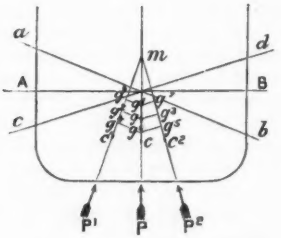
C centre of figure, *g* centre of gravity: now these vessels are not kept steady simply because the lines of pressure passing through their centres are equal and opposite, but also because of the great lateral pressures in the direction of the horizontal arrows.

Now, these two vessels could not, with accuracy, be compared in respect of rolling unless due allowance were made for the very much greater lateral pressures on *b*. For, suppose them each 300 feet long, *a* to be 21·2 feet deep, and *b* to be 29 feet. The centre of pressure of *a* would give 928 lbs. to the square foot: that on *b* would be 1,152 lbs. to the square foot, *i.e.*, on *a* 300 × 21·2 × 928 = about 3,140 tons; *b* 300 × 29 × 1,152 lbs. = about 4,790 tons lateral pressure to limit rolling either way.

Though it may be said truly that *a* has the greater breadth and stability, yet her greater breadth entails greater leverage for the sea to disturb her.

There are various means of rolling vessels, as by racing men from

FIG. 4.



side to side. Suppose Fig. 4 to represent a vessel at rest, AB the water-line, *c* the centre of figure, *g* the centre of gravity, *m* the metacentre.

Suppose, now, her crew moved over, and *ab* to become the water-line, *c* will be moved out to c^1; but *g* being, so to speak, a fixture in the ship will be moved out of the perpendicular by the distance gg^2, and when she has completed the half roll, the men to be raced over to the other side. Now c^1 will be moved over to c^2, but g^2 will be moved over to the other side and out from the perpendicular on that side to g^3, having been forced past the perpendicular. This process will be repeated every time the men are raced across the deck.

Now, if this process be very nicely adjusted, so that the racing of the men synchronizes with the motion impressed on the ship, in this case an increased impulse will be given to the motion of the ship, but an increase will be given to her angle and time of roll; it is evident that as the angle of roll is increased, the distance that *g* will be carried out from the perpendicular will also be increased, and with it the length of the lever gg^2, through which gravity acts, resisting inclination and tending to bring the vessel back with *c* and *g* in the same vertical straight line.

At the termination of any roll, gg^2 multiplied by the whole weight will give a measure of the rolling force—a measure of the resistance gravity has offered to rolling the ship—a measure of her stability at that angle, and the force that will be put forth to restore the ship to the upright when the men return to their original position. It is clear from the above that as stability is greater, the more resistance it will offer to motion, and the more it will limit the arcs of roll.

For if we raise *g* till g^1g^6 is only half gg^2, then half the force will roll her through an equal angle, or lower it till g^1g^4 is double gg^2, then double the force will be required to roll her through an equal angle.

In each case we merely move the centre of gravity, but this reduces the metacentric height; thus we have established that the less the metacentric height, the more easily the vessel will be rolled, and the greater the metacentric height, the more difficult it will be to roll her.

Moreover, the greater the metacentric height the greater must be the force to produce equal angles of inclination by frequent impulses to those produced when its height was small, consequently vessels with great metacentric height must be less subject to be rolled over by the crew racing, or by any other means.

If we suppose the ship's length to be increased, but the metacentric height to remain the same, by this the mass will be increased, as also the lateral pressures. As a consequence the increased mass, aided by the increased stability and inertia and lateral resistances, would all tend to limit both the times and arcs of roll.

It is obviously, then, most fallacious to compare ships on the bases of their equality of metacentric height when they differ widely in the two elements of mass and lateral resistances, and still more, thus to compare them, when they differ on other points as well as these two.

The question suggests itself—can the angle of roll be so increased by continued impulses by racing men from side to side in a ship till she is rolled over?

Certainly, if the metacentric height is small, certainly not, if it is

moderately great; for the lever gg^2 or the stability will increase faster with each increased angle than will the effect of the impulses, so the time will arrive when there will not be any increase of angular motion, and this will arrive earlier as the stability and lateral resistances are greater.

We have had proof of this in "swinging," when, by a muscular effort we have increased the angle of swing, the quantity becomes less and less as we approached the higher angles, because of the increased effect of gravity acting through a longer lever as we diverged more from the perpendicular.

But the immediate causes of excessive rolling when the elements in "ships" are not given in due proportion, is that which causes waves and waves, themselves.

The general causes of waves are differences of atmospheric pressures at one place over another; the effort to re-establish equilibrium produces sea and wind waves. These pressures, being vertical, impart a vertical motion to the water, which, escaping laterally, gives rise to progressive wave-motions, these starting earlier, and travelling faster than winds, give notice of their approach.

When the waves are raised the wind accelerates this motion, especially at the surface; consequently the form of the wave-face and wave-back never correspond. Neither can waves be of uniform size or motion; for besides the differences in direction and velocity of winds at the same place, nearly, and time, the waves are subject to interferences of ocean currents, tides, river streams, and lateral waves generated by smaller aërial currents from varied points.

All this shows how valueless are single observations of ships rolling, and how utterly impossible it is that amounts of roll recorded can be the result of "*surface particle*" motion.

Were ships only moved by such as they reach or strike them, they would be like fixed half-tide rocks, every wave would break over them and swamp them.

The fact being that the vertical pressure, alluded to, acts deep down on ships' bottoms, lifting the side before the wave reaches it, so ships are saved if unwise men do not swamp them with loaded sides or deck loads.

I must here premise that I do not admit the correctness of the premises with which the advocates of this theory start. I argue from their stand-point to show that on their own showing they are in essential error.

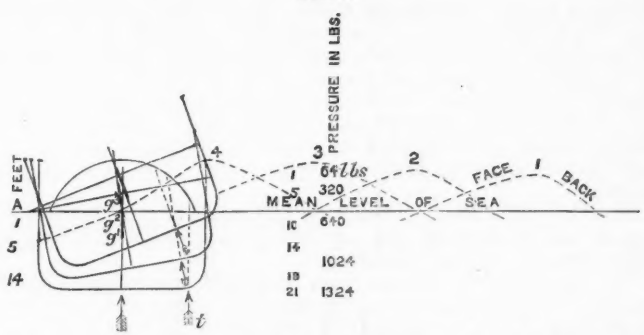
The metacentric method is only approximately correct, then, only on the hypothesis that the angles of inclination are infinitely small, and that all the motions are round a fixed centre of gravity, which is never even approximately true in a seaway.

It is expressly stated by Poisson and Gregory that this method is entirely inapplicable when there is a rise of the centre of gravity and a sensible increase of the angle of inclination.

What actually takes place in a seaway is shown in Fig. 5; first the vessel is shown at rest, then the lifting effect of the wave as it approaches and turns her round A outside of her:—

1 is a wave of 16 feet high, giving out a lifting pressure on one side at the lower arrow *t*, equal to the difference in the height of the

FIG. 5.



columns on either side; *i.e.*, the pressure on the side of the wave is at least 1,024 lbs. per square foot, that on the other side is only 512 lbs. per square foot.

This pressure produces a vertical and onward motion of wave that lifts and rolls the vessel, starting her even before it reaches her side.

As it approaches nearer it lifts her further, as represented by waves 2, 3, and 4 in the figure, and continues to lift her while turning her round A, till the crest of the wave has passed the middle line of the ship, after which it lifts the opposite side, arrests the forward roll, and rolls her back with the assistance of gravity which, till this time, has been resisting motion.

The motion proceeds from there being greater buoyancy on the upper or right hand side of figure, so the line of upward pressure passes to the right of the centre of gravity and the still-water metacentre, and until the wave passes the middle line of the ship, then it passes over to the left or lower side, lifting up that and effecting the back roll; the locus of the line of support is along a line such as the dark curve Fig. 5, on which it traverses forward and back as the ship rolls in a seaway.

The imaginary metacentric heights, shown also in short thick lines, clearly cannot exercise any influence on the motions.

It is equally obvious that as the vessel is more inclined, *g* is carried further from the middle line and acts through a longer lever, and in that degree resists rolling; the lower *g* is the longer will be the lever, therefore the less will be the angle of inclination from a given wave.

If *g* be near the line of support or curve, a small force will throw the ship on her beam ends. As this rolling force passes on one side of the centre of gravity, if that be high, there is always danger apart from and besides the danger from sail, or hurricanes on the hull and masts.

This will account for the number of war and merchant vessels

thrown on their beam ends in seas, many of them without any reduction of their lower weights.

Though the still-water metacentric height is said by Messrs. Froude, Reed, and White to be a prime factor in producing motion, it is seldom, if ever, a factor in producing motion in a seaway, for the position of a ship at each moment is the result of the buoyant action of the wave acting on the ship's side next to it, and its effect is opposed and limited by the action of gravity. If a metacentric height were known in such case, as it is not, and represented factors, for it is not one itself, it would represent two opposing factors—one occasioning motion, but the other opposing it—it displays ignorance of first principles to assert that metacentric height, less or more, is a cause of motion.

There are other elements besides a low centre of gravity that limit arcs of roll; to these we must now refer, I mean depth of immersion, square form of section, and mass.

The resistance to rotation from increased immersion increases rapidly because of the increase of lateral pressures—those at 12 feet depth being 768 lbs. per square foot, but those at 24 feet are 1,516 lbs. per square foot.

From the great areas of large ships these amount to thousands of tons; bilge keels will exercise small influence in comparison, but so far as these decrease the angle of roll and increase the times, they prove that the metacentric height and time of roll are not equivalents as contended for by the above gentlemen.

To look at the figure is to be convinced that increased breadth—all other things being equal—increases the lever through which the rolling power of the wave acts, and hence increases its effects in disturbing the ship.

This wave-action commences earlier as the ship is broader and continuing a longer time, moving at an equal rate; it is longer in passing across the wider ship, therefore must produce both quicker and more extensive angles of roll.

It has been stated that weighting the sides would be favourable to limited angles of roll. If the sides are not water borne because of accumulated weight, they will not be moved so early; but it is evident that they must lift with the wave, or the wave will break on board the ship—a far greater defect than their lifting early—for one means only increased motion, the other damage or total loss. And again, having lifted her late, her greater momentum would carry her further; and the wave having passed the middle line would have more work to check the roll, and reverse its direction. Nor is this mere speculation, for it is well illustrated in the fly-wheel of a factory engine that takes up the motive force given off when a thousand spindles are thrown out of gear, not to be lost, but given out when these spindles are again brought into gear.

This is confirmed by all nautical experience, but lest this should appear to be a dictum of mine, and as there is a tendency to worship the idols of the forum, we quote two notable authorities.

Sir Spencer Robinson gave as his reason for not increasing the

armour on old ships:—"*Our experience seems to show that all wholly "armoured ships roll the heaviest, and that of the French corroborates it "in the strongest possible manner.*" (*See* "Blue Book and Report," by Captain Hore, R.N.)

The French Admiral Paris said:—"*The ironclads roll more than the "old ships and bury their guns under the waves.*" Thus facts, authorities, as well as natural laws, contradict the dictum of Messrs. Reed and White, that it is a popular fallacy that weights on the sides tended to make vessels roll *deeply*.

It is accepted as an axiom by those who contend for the truth of Mr. Froude's theory, that if a ship's stability or metacentric height be great, her period of roll will accord with the period common to waves, so synchronisms and increased angles of roll will be given at each double swing till the vessel is rolled over.

Ten years my challenge has been before these gentlemen to produce one vessel where such has occurred; I will now take a step further, and say such cannot occur.

The father of inductive science says:—"A single instance is suffi-"cient to refute the validity of a supposed law. If that which, "according to our rule, ought to occur fails to occur on one occasion "only, this is proof that the rule was no better than an idol."

Now, this alleged rule has failed on every occasion, and we have thousands more of negative instances against the idea of its being a rule.

We might rest here, but think it important to establish that there never was any ground for supposing that ships could be thus capsized, if only they possessed the measure of stability that had hitherto saved them from it, nor could we believe it possible, unless like some would-be philosophers, we believed that globules of water-like protoplasms, as they assume, were individually gifted with greater prescience than men, and were collectively, as it were, by a "fortuitous "concourse of atoms," agreed to alter their courses and periods to overthrow unhappy vessels and drown their crews!

The system was exhaustively condemned by an experiment conducted by Mr. Froude himself.

The "Devastation" and "Sultan," two ships of 9,000 tons, were rolled in smooth water, by racing their crews across their decks forwards and backwards.

The angle reached by the "Devastation" was only 14°, and it was stated she could not be forced beyond this, while the angle reached by the "Sultan" was 29½°; after racing the men many times, orders were given for the men to cease running, loose things about the decks and gear not having been specially secured, for no one, it was added, anticipated such liveliness on "Sultan's" part.

The "Sultan's" period was 17·7 seconds, that of "Devastation" only 13·6. After the men had ceased, the "Sultan" made 60 oscillations before she reduced her angle of roll to 4°, but 40 oscillations brought "Devastation's" angle to seven-tenths of a degree. Thus all the evidence was in harmony with my argument and opposed to the new theory.

1. The "Sultan," with 2·4 feet of metacentric height, might not be rolled further, even with her *high* side, lest she should be rolled over. But the "Devastation," with a metacentric height of 3·5 feet, and notwithstanding her *low* side, could not be rolled to more than half the angle reached by "Sultan."

2. The vessel with the greater moments of inertia was rolled to double the angle that the vessel with the less inertia reached.

3. The "Sultan," with the higher centre of gravity by 6 inches, less stability and greater moments of inertia than "Devastation," was rolled through double the angle and was double the time in coming to rest.

But this only represents the action of ships rolled by racing their crews, yet, under the superintendence of the author of the system, who fixed the exact time for the men to race (and extreme exactness was necessary to produce even this evidence of failure as to the supposed law).

As I do not believe the particles individually or collectively to possess the intelligence to select the time when the fatal impulse is to be given, I may be permitted not to believe that any ship can be upset by many synchronisms. But I do believe that any ship, having little stability, may be caught by a rapid translatory wave and turned over, particularly if inclining, under sail, in the direction in which the wave is moving, and she possess other small elements of resistance to rotatory motion.

This is often illustrated by boats in surf, and vessels of considerable size when light being rolled over by solitary waves and bores in tidal waves.

But not to leave any point open to doubt, let us examine still further.

Let us suppose a vessel of a five-seconds period to be set rolling by waves of five-seconds period, and a synchronism to occur, and thence an increase of angle of roll, but then, as Professor Rankin says, her period will also increase, then also further synchronism would cease, unless the waves have the power to change *their* periods to preserve the law of Messrs. Froude and Reed, and to secure the needed synchronism for a capsize.

If any still contend that the waves possess this power of accommodation, to save time, I must make them a present of the argument.

I ought to allude to those wonderful surface particles that are supposed to exercise such preternatural influences on ships, that all elements, except metacentric heights, vanish, and gravity is merged in the gravity of these particles that once occupied the place the ships then occupied. So much so that it is said that "a raft representing "one or more of these would so influence an observer standing on it, "that to him the mast would appear to keep truly vertical and the "raft to remain perfectly steady, while it might be rolling through an "arc of 15° or 20° once every four or five seconds," also that "a "pendulum hung to the mast would also be affected by the wave-"motion, and would coincide in direction with the mast;" strange to

say, these same gentlemen say that a pendulum shows too great angles of roll and ought to be superseded, both cannot be correct?

Were this but half true of ships then it were unnecessary to secure anything, guns and shot, or cargo; man ropes, fiddles, and even sea legs would be surplusage, and sea sickness a thing of the past.

The believers of this theory, however, unconsciously disbelieve it, or why incur the expense of the Bessemer failure, instead of applying this raft theory? Why have recourse to the dangerous, in their estimation, expedient of giving enormous stability and low centres of gravity?

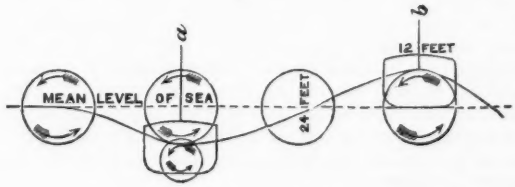
It is all well described in the language of Hamlet to Polonius, "words, words, words," facts and principles are flung away, and word-painting of imaginary things is substituted.

The moving forces of wave action are on the bottom and sides, low down; the surface particles neither represent this action, nor do they exercise more than the smallest influence, for a foot area at 3 inches depth is subject to only one-hundredth part of the pressure that there is on a foot area 26 feet down.

How could it be as is argued, that the resultant to surface particles on a wave-face should also be the resultant of all the particles displaced by a ship, seeing it is stated that the particles in every wave make a complete circuit within the height of the wave, therefore, instead of these having one resultant, there are resultants to curves all round these circles; instead, then, of a ship moving as a surface particle, she would, if at all, take a resultant due to the aggregate motions of particles moving in every direction, thus obliterating any resultant such as that assumed.

Thus, in a 24-foot wave, a vessel drawing 12 feet with 12 feet of breadth, would be entirely under the influence of the upper half of

FIG. 6.



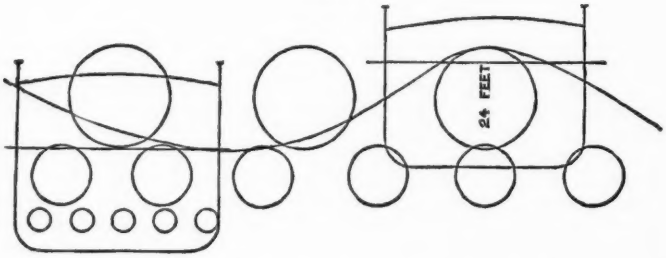
the circle, supposing her to coincide with it, and when on the wave, one side would be subject to upward, the other to downward motion, while the portion above would have a horizontal motion in the direction the wave was moving; in the hollow it would be very limited and conflicting.

But a vessel drawing 24 feet water and 48 feet or greater breadth, would embrace two or three large circles and three or four smaller circles when on the wave, but when in the hollow scarcely any at all

But, in truth, the whole theory is simply impossible.

The fact is Mr. Froude has overlooked that the motions of water-particles could obtain only because of their fluidity and smallness, such as are impossible to large, rigid bodies, like ships, enormously large as compared with particles.

FIG. 7.



If a floating body could take the motion of particles it must be wholly immersed, and turn over, as they do—hardly convenient either for boats or ships.

Mr. Froude has also assumed that ships and waves are moved simultaneously, yet there is no foundation for this; atmospheric pressure moves the waves directly; ships are wholly uninfluenced by this directly, their motions are derivative and later, through the waves.

His theory requires that all the particles that any ship had displaced should have had motions all in the same direction, and at the same rate; that they should move in equal parallel concentric circles simultaneously, so that the ridges of the waves should be in straight lines and equidistant, these concentric circles having a common axis, and the ridges parallel to each other. And more, that the displaced particles should, by some inconceivable means, convey to a ship occupying the space that some such particles once occupied the motions they had had before they were displaced. Moreover, that their periods should be on some self-governing sliding scale to accommodate themselves, for the purpose of synchronisms, to the different periods of ships and to the continuously differing periods of the same ship, from each new impulse, that should be the victims of the dreadful synchronism.

Anyone acquainted with the sea must know that no such parallelism of waves, nor equality of height, nor form, nor power of adaptation, ever does obtain, but the contrary; they are always more or less confused, and that the particles moving according to the law of least resistances move out more or less on one side or the other as they advance, nor can the wave-ridges be straight, for, besides the fact that the directions of winds are curvilinear, they are uneven in their action, as anyone who has sailed with a fleet of ships must have perceived.

The astonishing conclusion arrived at by Mr. Froude ought to have convinced him that he did not arrive at it by a true induction, *i.e.*,

that stability was the *lever* by which the wave sets the ship in "motion."

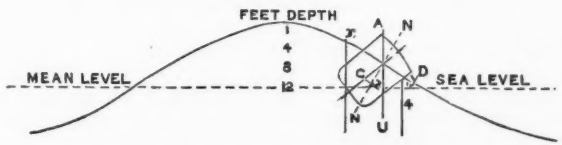
The lever of stability has no existence till motion ensues, therefore cannot be both cause and effect.

To say that it is, is about as reasonable as saying that the spectator on the raft, spreading his legs out to save himself from being thrown down, was the cause of the motion of the raft that no doubt disturbs his equanimity till he has got his sea legs.[1]

Mr. Froude seems to have been conscious of a difficulty, for he changed the import of the word, and called stability by another name, while he appropriated stability otherwise, as Mr. Reed said for the purpose of scientific terminology, unconsciously to deceive himself and others. How foreign architects will smile at the idea that neither their countrymen nor ours were scientific, at least on nautical matters, till the "new school of thought" arose!

Mr. White, in his lecture "On the Behaviour of Ships," adopts Mr. Froude's theory, but unwittingly demonstrates its incorrectness. He gives the cross section of a ship, on which he represents his "virtual upright," which he assumes would be the resultant of *all* the forces acting on a ship, even though these embrace particles moving in four main and opposite directions with varying velocities.

FIG. 8.



He represents the ship as inclined beyond his "virtual upright," but does not tell us how she came thus, or if she dropped from the sky on to the wave in that position, for he commences his argument as if her motion only commenced with the motion, which he ascribes to stability acting through GZ, to bring the ship, as he states, up to the line NN, his virtual upright.

Let me give here Mr. Froude's fundamental proposition, for it will tend to explain why Mr. White's argument is contrary to his illustration:—

"The effort of stability is the lever by which a wave forces a ship

[1] Again, whether it be true that the particles move in circles or not in their earlier stages of wave-motion, observant sailors have seen hundreds of times that particles when running into crests, as is distinctly visible, move vertically.

The pyramidal seas in cyclones prove that winds moved in curved lines, and though there it is excessive, yet all winds and waves are influenced in their direction by the relative motions of the earth's surface through space, consequently there could not be that equality of wave-motion that would secure synchronism apart from the many other causes of disturbance, so the parts of waves would reach parts of ships at different times, angles, and heights, a turn of the wheel would serve to evade a synchronism, but nothing could ensure one.

" into motion, so that if a ship were destitute of this stability no wave " that the ocean produces would serve to put her in motion whether " that stability were due to a broad plane of flotation or to deeply " stowed ballast."

Fig. 8 is Mr. White's Fig. 3, in reference to which he says:—" On " the right hand side is shown in cross section; the instantaneous " position of the virtual upright is indicated by NN, and the masts " of the ship are inclined to NN at an angle GMZ, G being the " centre of gravity; GZ is drawn perpendicular to NN, and instan- " taneously the righting moment tending to bring the masts into " coincidence with NN, is given by the equation. Righting moment " =apparent weight of ship × GZ."

Now in Mr. White's *argument* the ship's gravity is merged in the gravity of the particles, for he contends that the ship has only a tendency to come to NN, the assumed resultant of the wave, and *not* to a perpendicular to the earth to which the ship's gravity would bring her if allowed, but his illustration shows that the wave has produced the motion, and has carried the ship beyond his virtual upright, and it shows further that it is *gravity alone* that is resisting inclination, and as the wave recedes, urges the ship to come up to the perpendicular, not simply to a perpendicular to the wave-face NN, but to the earth!

The theory requires that stability should be the cause of motion, and so the action of the wave is ignored in the argument, but shown in the illustration, and stability, under the term "righting moment" is implicitly stated to be the originator of motion.

It is obvious from Mr. White's figure that the upper side where the water is higher by four feet which involves a lifting and rolling pressure greater there than on the right hand side, acting through the lever of half the breadth or more, consequently the righting is entirely due to the gravitation of the ship acting through a lever equal to the distance G is from the true vertical, and longer than GZ, and not in any degree to buoyant action, for this is deficient on the lower side, therefore also the metacentric height has no influence.

To assume, as has been done, that the ship's gravity ceases to act on a ship in the midst of waves, is as reasonable as supposing that gravity ceases to act on a shot while it is under the influence of exploded powder!

Mr. Reed says I have misrepresented Mr. Froude. Let me, then, give his version of Mr. Froude's views:—

Mr. Reed says:—" A ship floating among waves is obviously under the action " of two forces—gravity and the centrifugal force due to her own rotation." Then asks, " What more natural, then, than that she should seek her, as her position of " rest on the wave, that due to the aggregate effort of *gravity* and centrifugal force " of all the particles for the moment displaced by her?"

1st. She has no rotation of her *own*. She is forced round by the wave.

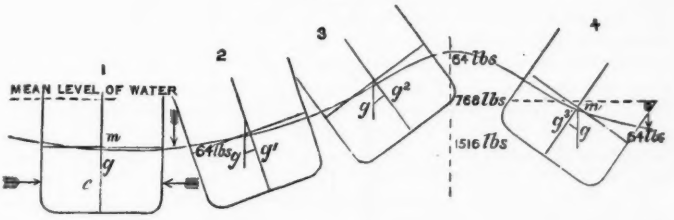
2. She could not seek rest in that which is continually changing.

3. How could she merge her own gravity in the gravity of particles *displaced* by her?

Is it that, in tossing them up and out in all directions, she impresses them with some of her motion, and that they, in return, impress her, not with reactionary motion, but the centrifugal motion they had had before they were displaced?

The true explanation of the position of the ship in figure 8 and of the forces acting on her is the following:—

FIG. 9.



Suppose Fig. 9 to represent a ship at rest, m the metacentre, g the centre of gravity, gm the metacentric height. It will be observed that when the ship is upright there is no lever of stability to disturb her as is asserted; the ship is retained in this position by the force of gravity pressing down through g, and a pressure up through c acting in the same vertical straight line, and by the equal and opposite lateral pressures acting in the direction of the horizontal arrows, and she continues at rest till this power is overborne by the vertical pressure of the approaching wave acting in proportion to its greater

How difficult it is to write sense in support of a radically erroneous theory!

The writer of the above did not understand the problem. Both he and Mr. Froude have deceived themselves by confounding the *gravity* of the ship in one sentence with *gravity* which is that of the particles in the other.

The gravity of the adjacent particles occasions pressure and buoyancy which, by lifting one side at a time, rotates the ship so fast and so far only as the ship's gravity and other impediments to motion will allow.

Mr. Froude says:—"The *rationale* of my proposition is readily understood by "reflecting on the condition to which we must adhere, if we would give motion to a "board on which a marble or an adjusted level rests; or, again, to a cup brimful of "liquid, without displacing the marble or disturbing the level or spilling the liquid." Herein lies his fallacy, shown also in his fundamental experiment with a tray of water and model on it, suspended by three strings.

He supposes this model and water and tray, set in motion slowly by the hand, *i.e.*, by one force setting all the others in motion simultaneously, to be like a ship set in motion by the wave, but ship and wave-motion do not commence together, nor are their motions due to the same cause, therefore there is no analogy to his illustration, as the difference in the periods further prove. Mr. Froude admits that his theory is markedly at variance with the views which have been expressed by men whose authority deservedly ranks high on questions of naval architecture, and adds, in adopting his fundamental proposition, it is unnecessary to take separate account of the ship's centre of gravity, *e.g.*, as to whether it is *above* or *below* the water-line, or of the ship's peculiar form, as to whether it "tumbles home," or spreads out, symondite fashion, above water, for full account has been taken of them in determining the ship's scale of stability in still water.

Were his view correct, Mozeley and Atwood would have written in vain; the last showed the defectives of the metacentric method to measure either of the above conditions it is said to take account of; Mozeley gave a formula for determining the stability by the rise or fall of centre of gravity from the cause of falling out or tumbling home!

height and nearness, and acting through a lever greater than the half breadth lifting her into the position 2, Fig. 9, in this a lever is developed by g, being carried out to g^1, and when lifted to 3, Fig. 9, is carried further to g^2, and so lifted further till the crest of the wave passes the middle line of the ship, then the wave commences to lift the other side, during the whole time the wave was inclining the ship's gravity was resisting, and more so as g was moved first to g^1, then to g^2, but the moment the wave commences to lift the other side, gravity helps to bring the ship upright, but when the wave inclines the ship beyond that, then gravity begins again and increasingly resists inclination. Finally the ship is brought into the position of 4, Fig. 9, the position represented by Mr. White; therefore the wave and not gravity, nor stability are disturbers.

Now I have but to show by illustrations the truth of all the foregoing, and that neither one nor both, nor high centre of gravity, nor a small metacentric height, occasion small angles of roll, but the contrary:—

1. The "Superb" and "Vanguard," both old and sister ships; the former was immersed one foot more by a greater quantity of ballast, provisions, and water, therefore having a *lower* centre of gravity and a greater metacentric height, yet she sailed *faster*, rolled through *smaller arcs* and more *slowly* than "Vanguard!"

Her longer period and smaller arcs were due to her greater immersion which gave her a practical keel of 186 feet area resisting motion, involving a pressure of nearly 120 tons against rolling!

2. The following table of oscillations is given by the Constructors of the Navy, but I have added metacentric heights:—

	Metacentric height.	May, 1865.						
		6.	7.	8.	9.	10.	11.	12.
"Edgar".....	4·5	..	..	9·8	9·25	8·88	6·08	
"Achilles".....	3·0	6·45	7·1	9·87	11·27	10·37	10·0	6·4
"Hector"	4·6	11·5	11·37	10·29	11·74	10·53	9·28	3·33
"Prince Consort"	6·0	13·9	10·41	9·66	12·05	12·2	10·07	8·66[1]

[1] In the report on the "Monarch" by the Constructors of the Navy, who gave the above table:—

"Thus under various conditions of winds and weather, under steam alone, and "with both combined, the 'Prince Consort' rolled more quickly, and far more "deeply than the 'Achilles.'

"It was known that the metacentric height in these ships was in 'Achilles,' 3·1 feet, and in 'Prince Consort,' 6 feet; and we are furnished with a most complete and remarkable illustration of the correctness of the scientific view of the case."

Here, as usual, it is assumed that there are no differences in these ships that would account for the differences in times and angle of roll recorded, but that of the differences in this metacentric height, yet they differed in weight, 900 tons, in

On the only occasions on which oscillations of "Edgar" are recorded, they are less than those of any other ship, yet she had as great or greater metacentric than all but one. Moreover, she was smaller than any, and much smaller than "Achilles," that had the smallest metacentric height.

On one occasion the "Prince Consort" rolls *less* than "Achilles," on another occasion these are *equal*, and there is little difference on two other occasions, and yet her metacentric height is *double* that of "Achilles!"

The "Hector" on two occasions rolls less than "Achilles," and yet she has a much greater metacentric height.

This table proves that there are other elements that are ignored by the advocates of the new theory that produce these results. It is not science to ignore any factor in a problem.

The superiority of "Edgar" is because she did not carry armour, therefore armour causes ships to roll more *deeply*.

The following table is given by Mr. White to prove that there is a necessary connection between short periods and large arcs:—

Squadron of 1871.	Still-water period.	Mean arcs of oscillation, doubtless should be maximum arcs.
	Seconds.	Degrees.
"Lord Warden"	5 to 5¼	62
"Caledonia"		57
"Defence"		49
"Prince Consort"		46
"Northumberland"	7 to 7½	38
"Minotaur"		35
"Hercules"	8	25
"Topaze"	5	22

It will hardly be credited that a gentleman professing to be a master in the science of naval architecture should compare these ships on the bases of their periods alone, and attribute the angles of roll to the difference in that respect, since they vary in masses from 330 tons to 4,500 tons; in length, from 7 to 127 feet; in draught of water from 4 to 18 inches, and in weight of armour from 300 to 1,100 tons.

Moreover, he omitted from this official table the little "Topaze," that rolled only 22°, though she had a period of only five seconds, which is entirely adverse to this theory.

Her superiority was because they carried from 600 to 1,770 tons of

length 107, and in draught of water 15 inches, which besides the effect of the great difference in mass, means 3,000 square feet of vertical longitudinal area, or a pressure of 1,600 tons greater on "Achilles" to limit her times and arcs of roll!

Yet this is called the "scientific view!" Science does not overlook any factor in a problem, still less does it ignore every influential factor, and assume that the results observed are due to that which is not a factor, or if it represents factors in a measure, they are opposing factors from which their result would be negative!

armour, and she had none; she was better than the "Hercules," though the latter had a greater lateral pressure, resisting rolling by 1,500 tons!

Then to carry armour is a disadvantage! The "Northumberland" rolls less than the "Lord Warden," but she is 3,000 tons larger, 120 feet longer, and has a greater lateral pressure by 1,500 tons to prevent rolling either way.

Here is another table given to prove that long periods necessarily give short arcs. It is true we are not troubled with their metacentric heights, but the period is assumed to be an equivalent. Nor is this the only assumption, for it is supposed that a difference in metacentric heights makes the differences in angles of roll, and nothing else; all other differences are ignored, the plan is convenient, if not accurate; you must not expect everything to be correct!

Detached Squadron of 1875.	Approximate still-water period.	Arcs of oscillation.
	Seconds.	Degrees.
"Newcastle"	5	29·6
"Topaze"		22·6
"Immortalité"		20
"Narcissus"		19·6
"Doris"		18·7
"Raleigh"	8	5·8

It is not sought to be explained how the angle of "Newcastle" with the same period as "Doris" is 29·6°, while that of "Doris" is only 18·7°, *i.e.*, *no* difference in period, which is said to be the prime factor in rolling, produces 11° of angle, *i.e.*, a great effect without a cause!

Or to compare "Narcissus" with "Raleigh," a difference of three seconds of period only produces 13° of angle, *i.e.*, a great cause, if we are to believe the arguments but not the illustrations of these theorists, without an adequate effect!

The "Raleigh" is longer than any of those she is compared with from 40 to 70 feet, from 1 to 3 feet less beam, and draws more water from 2 to 3·8 feet, and in mass exceeds them by from 1,200 to 1,600 tons, and has a lateral pressure of 900 tons greater than "Narcissus." These explain "the differences" without having recourse to the groundless idea that difference in metacentric height is the cause. I need not waste your time by further comparison.

Now we come to an entirely different table, to which I must beg your special attention, as illustrating the *opposite* of Mr. White's *argument*.

Heretofore he has assumed that period and metacentric height were equivalents, if that idea is not given up, there is something he wants to disguise from himself. He gives the complement of period and the metacentric heights, I add the angle of roll and period.

	Rolls per minute.	Metacentric height.	Angle of roll.	Period.
	Times.	Feet.	Degrees.	Seconds.
"Prince Consort".....	12	6·5	46	5
"Miantonomoh"[1]	20	14·0	10	3
"Sultan"[1].....	7 or 8	2·5	29½	7 or 8
"Hercules"[1].....	7 or 8	2·7	25	7 or 8

We have here the most emphatic contradiction of the theory of Messrs. Froude and Reed; for we have by much the greatest metacentric height associated with by much the smallest angle of roll, and more, we have by much the greatest metacentric height with much the shortest period.

Had there been any truth in the theory the "Miantonomoh" must have capsized within sight of her own shores, as she possesses six times the amount of metacentric height that "Sultan" and "Hercules" had, and that were said only to be safe from rolling over because they had so little!

The explanation is that she drew 11 feet less water than the "Hercules" and was 75 feet shorter; this involved lateral pressures as follows:—On "Hercules," 4,200 tons; on "Miantonomoh," 900 tons, or four times the amount of lateral pressure on "Hercules" to arrest rolling motion either way.

The "Miantonomoh," though she had only 3 feet of freeboard, passed through heavy seas and did not capsize, proving what I said here relative to the "Captain," that she was *not* lost because of her 6-foot side, but because of the deep empty bottom given her by Mr. Reed.

An Officer of the American vessel was asked if she was steady, and answered, "Why, Sir, when it was blowing furiously I took a bottle "and turned it upside down with its cork on that in another bottle "on the table and it never moved." Doubtless he was poking fun at those who thought, and perhaps still think, she ought to capsize; or if they contend that this was a proof of the correctness of the raft theory, that she was rolling 15 or 20°, but neither the bottle nor the Officer knew it; but still the advocates of the raft theory must establish a change of law to explain how with 14 feet of metacentric height and a three-second period she should have rolled only 10°, or abandon their assumed law. I do not see any other alternative but that of supposing that the Americans have omitted a cypher—100° instead of 10° roll—a cypher is not much, and everyone is open to make mistakes.

The Captain of the "Crocodile" reported that when lying alongside "Warrior" she rolled 30° sometimes 40°, while the latter was apparently motionless; the "Warrior's" metacentric height was 3·5 feet, the "Crocodile's" less than 2·7 feet, for she was very light. The

[1] The "Sultan" maximum roll is avowedly not recorded, and I doubt if that of "Hercules" is either.

explanation is that the "Warrior" drew 25 feet, the "Crocodile" about 15 feet.

The "Serapis" was reported to have rolled helplessly on her side through large arcs when hove-to. Short of coals, provisions, and water, she also had little stability and of comparatively small draught, having, according to the theory, a most desirably long period, probably ten seconds. Then, if the waves had a five-second period she would have made half a roll, the effect of one wave, when another would come up and throw her back on her side; under such circumstances her sails could have been only of the least service to her, she had to be towed into harbour.

The French wooden ship "Montcalm" was said to have rolled 20° when our "Audacious" rolled only 2°. It was not said whether they were equally light or loaded, or one in one condition, the other in another, or whether they were brought beam to the sea at the same time or in the same relation to the wave; yet there is a right and a wrong time to do this.

There was no appreciable difference in their metacentric heights, but the "Audacious" had 350 tons of ballast on her floors; she was nearly double the size; she drew 15 inches more water; she had bilge keels, and carried 160 tons less proportion of armour than "Mont-"calm." I apprehend that credit has been put on the wrong side of the account here.

Mr. Reed said, at the Royal Institution, that the double bottoms were made expressly large to facilitate raising their weights, as it had been found that this tended to "check" rolling, and vessels have been supposed to illustrate the advantage. Except in two cases this raising of weights does not appear to have been done. Metacentres have been lowered, but that is radically different and much more safe.

In general, the old ships had their centres of gravity little below the load water-line.

The "Penelope" had hers 1·35 *above* the load water-line, she rolled 60°. The "Pallas" had hers ·4 of a foot *below*, she rolled 68°. The "Iron Duke" had it ·6 below, but she was one of those that had to be ballasted, by which it was lowered from its original design about a foot.

The "Conqueror" had hers ·8 below, an old ship. She was thrown on her beam ends by a sea without having any sail set. The "Her-"cules" has hers 1·38 below, she is bad to steer in a seaway. The "Achilles" has hers 1·52 feet, "Minotaur" 1·99 feet, "Warrior" 2·28 feet, "Sultan" 2·35 feet, "Devastation" 2·84 feet, "Thunderer" 2·84 feet.

That is, though contrary to their theory, the centres of gravity, instead of being raised, are wisely being lowered and the theory abandoned.

The following table will throw light on our subject.

	Period of roll.	Meta-centric height.	Maxi-mum angle of roll.	Height of centre of gravity.	Weight of armour.	Displace-ment.
	Seconds.	Feet.	Degrees.	Feet.	Tons.	Tons.
"Pallas"	probably 5	4·5	68	·4 below	560	3,656
"Penelope"[1].....	probably 5	3·5	60	1·35 above		
"Miantonomoh"[2]....	3	14·0	10			
"Hercules".....	8	2·7	25[2]	1·38 below	1,481	8,700
"Prince Consort"....	5½	6·5	46	2·15 below	941	6,600
"Devastation".....	7½	3·5	27½[2]	2·84 below		
"Raleigh".....	8	2·4	66½	..	None	5,200

If we compare "Pallas" and "Miantonomoh" as to period and metacentric height, we learn that these are not equivalents as contended for in Mr. White's tables.

The same also, if we compare "Pallas" and "Prince Consort," or "Penelope" and "Devastation," or "Hercules" and "Raleigh," or "Miantonomoh" with any of them.

Again, if we compare "Pallas" with "Prince Consort," on the supposition that greater metacentric height produces greater angles of roll, they afford a distinct contradiction of the idea, or if we compare "Penelope" with "Devastation," or "Miantonomoh" with any other on the same point, they all contradict the idea.

Nor do we find that a high centre of gravity contributes to small angles of roll, for the vessel with the highest centre of gravity rolls 60°, and the next highest, "Pallas," rolling 68°, and those with low centres of gravity are the least rollers, "Devastation" and "Raleigh."

It is contended that weight on the sides of ships contributed to small angles of roll; were that correct "Pallas" ought to have rolled less than "Prince Consort," and "Hercules" more than "Mian-"tonomoh" and "Raleigh."

Had "Pallas's" excessive rolling been attributed to her stupid form, which involves rolling round a diagonal axis, and to her high centre of gravity, there would have been reason in it; while these exercise a baneful influence, that which is the main cause was her small lateral resistance, great weight of armour, and undue proportion of breadth to length.

The lateral pressures were about as follows:—

[1] The great disproportion between half breadth and immersed depth in "Penelope" and "Miantonomoh" makes them eccentric wheels, in rolling, from which there is an unusually great rise and fall of their axis, hence, also, rapid and large angles of roll.

[2] Maximum angle of roll not recorded; this is probably the same of "Hercules" —why?

"Miantonomoh"	900 tons.	"Penelope"	1,300 tons.
"Pallas"	1,900 „	"Raleigh"	3,060 „
"Devastation" ..	3,600 „	"Hercules"	4,200 „

Mr. Reed, who designed "Pallas" and "Hercules," while insisting on the necessity for a high centre of gravity, lowered that of "Hercules" below that of the "Pallas" by nearly 1 foot, and reduced her disturbing element of breadth from 1 to 4·5 in "Pallas," to 1·55 in "Hercules," while he largely increased the mass of the latter as compared with her length and breadth.

The "Hercules" has a greater disturbing element than "Raleigh," and carries a large weight of armour, "Raleigh" not having any, and has a further advantage in 180 tons of ballast on her floor.

On the contrary, the following vessels have all been thrown on their beam ends, "Algerine," "Raleigh" (old), "Camilla," "Sappho," "Ariel," "Star," "Nerbudda," "Victor," "Racer," the "Blanche" frigate, and the "Conqueror," 90 guns, and many merchant ships every year; not one while in their normal condition and not till their stabilities were reduced by the consumption of stores and their centres of gravity raised! Yet, according to the new theory, this was the condition in which they would have been most safe!!

The use of bilge keels proves that the reduction of stabilities has not produced the effects claimed for it, and notwithstanding so much has been done affecting the safety of ships and their crews, in opposition to received principles, nothing but irrelevant facts are offered in justification; when a real test has offered for truly determining the question, it is passed over without notice—I mean that of so much ballast having been placed in a number of ships, "Sultan" and her sisters, "Invincible" and her sisters "Raleigh," "Volage," "Inconstant," and others; by which their centres of gravity were lowered and their stabilities greatly increased.

It was no doubt conclusive against this theory, or Mr. Froude and his Committee would not have recommended the "Inflexible's" stability, which is represented by 8·7 feet, nearly four times that of the "Monarch," to be doubled in new designs, *i.e.*, giving them a metacentric height of 17 feet; greater than that of the "Miantonomoh," so condemned by Mr. White. It is not to be doubted but that the "Sultan" was improved by the addition of 150 tons to her previous 450.

We have seen that the "Invincible," when without ballast and subject only to a moderate wind on her bare masts, when turning, went over 17°, had she had sail on her or had a surface current carrying her upper part in the same direction, while the water below was motionless, thus tripping her up, a state of things not uncommon, she would have capsized, so also "Sultan" and her sisters if without ballast.

It is necessary to dwell on this, as it has been recommended to leave out this ballast or keep out weight *below* in new designs, without giving them any real equivalent, for that proposed is not such. But it is demonstrable that this would be fatal.

The following French ships afford equal testimony to the correctness of the views I have set forth.

	Period in seconds.	Angle of roll.	Metacentric height.	Weight of armour.	Displacement.
		°	Feet.	Tons.	Tons.
"Normandie"	5 to 5½	43·6	6·5	980	5,600
"Invincible"		41·4	6·4	980	5,600
"Couronne"		37·7	5·4	710	6,000
"Magenta"	7 to 7½	36	5·0	1,003	6,700
"Solferino"		35	4·5	1,003	6,700

Sir Spencer Robinson gave their metacentric heights as showing that the difference in these was the cause of the difference in their angles of roll, Mr. White affirmed it and gave their periods of roll, I add their weight of armour and displacements.

They assumed that there is no difference that could account for the differences in their angle of roll, practically that they are alike in all else, yet they differ in size from 400 to 1,200 tons, in proportionate weight of armour 170 tons, the two smallest ships carrying the greatest proportion, in length 28 feet; in breadth 2 feet; in immersion 3 feet; in vertical longitudinal area 1,300 square feet; all influential factors in favour of "Solferino," as against all the others, but mostly against "Normandie" and "Invincible."

With a difference of a foot in metacentric height there is only a difference of ½ a second in period!

With a difference of ·4 of metacentric height there is a difference in period of 1½ seconds!

And with a difference of 1½ seconds in period there is only a difference in angle of roll of 1·7°!

Yet with *no* difference in period in English ships, there is a difference of angle of roll of 16°, a great effect without a cause!!

Clearly establishing that, to say that metacentric height is the measure or cause of steadiness or otherwise, is as reasonable as saying it produces the differences in size, in form, and weight of armour!

It is due to the French to repeat Sir S. Robinson's testimony before the Committee on Designs—"It is also remarkable, that while the "number of oscillations per minute is almost invariable in the French "ships, whatever the amount of rolling may be, the greatest possible "variation in this respect is recorded by *each ship* of the English "squadron."

Could anything be more conclusive against the metacentric height theory than this? for it really amounts to his saying, "Give me the "choice of days, let me select my table of recorded angles of roll, and "I will give you proof of any view you like on the subject."

Manifestly there is a scientific adjustment of the elements in French ships that does not obtain in ours—the French ships represent law, the English ships absence of law—any way you please, and

yet this is supposed to give evidence of a fixed law on which to build a safe theory.

It has been said that the French naval architects have endorsed Mr. Froude's views, and have adopted the practice introduced by Mr. Reed into our Navy. If so it is something new in their history; generally we have followed them. If they have been misled by the strong reports from this side to go a little in that direction, I have no doubt they will be modified or not adopted wholesale before they will have been proved to be dangerous.

But I should like to have plain answers to the following questions:—

1. Have they accepted the theory that a ship should be treated as a surface particle? That when at rest she should be recognized as a solid body, but when in the midst of waves she should be taken out of this category and become subject to the laws of motion in fluid particles?

2. Have they accepted the dictum that the ship's gravity is to be held to be distinct from that of the particles when she is at rest, but when in the midst of waves it is to be merged in the gravity of the particles she had displaced?

3. Have they accepted the dictum, the basis of this new theory, that "stability is the lever by which the waves set ships in motion, "whether that stability be due to a broad plane of flotation or to deeply "stowed ballast, and that if ships were destitute of this stability no "wave would serve to put them in motion?"

4. Have they adopted the practice of raising the inner bottoms 4 or 5 feet above the lower floor to facilitate raising the weights from a belief that this has been found to check rolling?

5. Have they accepted the theory that weight concentrated on the sides and above tends to reduce angles of roll?

6. Is it their experience that in proportion as their ships have had greater stability of any kind, they have been found to roll over?

7. And as logically flowing out of the above if they have accepted them, do they teach that the proper distribution of cargo, &c., for safety and the integrity of the fabrics, is to place the heavy weights at the sides and above, and the light weights amidships and below, but not at the bottom; that there should be large empty spaces up to 5 feet in depth, according to the size of the ship?

Relying on their ancient fame we might answer in the negative; but the table given of their ships and their performances, proves that their constructors have not fallen short of the science of their predecessors. Two or three points may be mentioned in contrast with ours, but which happily we seem to be following.

Sufficient stability to make them safe and manageable, and this increased in proportion as the top weights are increased, and low centres of gravity, in all the ships mentioned, more than 3 feet below the load water-line, while ours range from 1·35 feet *above* to 2·8 feet only below!

Having submitted these questions to a French authority, I give the substance of his answer. "Our rule for full masted steamers is un-

changed, it is to give the amount of stability that has long been our custom. For steamers without sails to obtain a stable platform, we can either increase the moments of inertia or diminish stability. The former is seldom possible as this increases the amplitude of roll and takes away the advantage we seek. Thus, generally we seek to reduce stability, but this must be done with great prudence." Thus they hold that danger comes with little stability, while the Froude theory is that safety comes with little stability.

The damaging consequences of excessive rolling may be illustrated by the following—supposing "Penelope" and "Pallas" periods to be 5 seconds. These ships would roll through these degrees in an hour.

"Pallas" ..	..	48,000 degrees.
"Penelope" ..	..	42,000 „
"Albion" (old)	..	39,000 „
"Hercules" ..	..	12,000 „
"Miantonomoh"	..	12,000 „
"Raleigh" ..	..	3,000 „

Excessive rolling must disintegrate the fabrics, occasion great wear and tear and cost, and must militate against extended usefulness. The remedy proposed by Mr. Reed was said by Mr. J. Scott Russell to be worse than the disease, the loss of the "Captain" and "Eurydice" with 1,000 lives has fully justified this.

The "Miantonomoh" no doubt rolls 20 times in a minute, but as it is only through 10° it is not faster than "Hercules"—$8 \times 25 = 200$ and $20 \times 10 = 200$!

From a small damage "Hercules" would capsize, having only 2·7 feet of metacentric height; but "Miantonomoh" would be still safe after much damage, having 14 feet of metacentric height.

These facts are entirely in favour of my argument, for if very limited areas of bilge keels reduce the angle of roll and increase the periods, *à fortiori*, the greater areas of resistance to rolling, the result of differences in length, varying from 100 to 200 feet, and in depth from 12 to 20 feet, must produce vastly greater results in the same direction!

Thus I have established that all other things being equal, and science always recognises the *cæteris paribus*:—

1. That stability does not originate motion, nor cause larger arcs of roll.

2. That little stability is dangerous as facilitating a capsize, and makes vessels unmanageable.

3. That breadth in proportion, as it is great, increases the lever by which the waves disturb vessels.

4. That a high centre of gravity occasions greater arcs of roll, and is dangerous. That whenever the centre of gravity has been high, and the stability small, and the one has been lowered and the other increased by ballast low down without any other alteration, the ships have been benefited not only in rolling less, but made more safe and improved in other essentials.

5. That weights on the sides tend to occasion longer arcs of roll.

7. That ships do not move, nor can be treated of as moving, as a surface particle in the wave that floats them.

7. That ships' gravity cannot be merged in that of the gravity of the displaced or any other particles of water.

8. That great metacentric height is not incompatible with small angles of roll, as has been taught, for the "Miantonomoh" with the greatest, *i.e.*, 14 feet, has nearly the smallest angle of roll, 5°; when the "Augusta," said to be a remarkably steady ship, and steadied by sail, with waves of 20 and 25 feet rolled 18°!

9. That a ship does not drop down on the wave as was suggested as possible in "Naval Science," nor become an integral part of the wave!

Lastly, that the system which rejected that which had been found ever since the present laws of nature have existed, as being the safest and most effective, for that of minimizing stability, by raising the centre of gravity, giving deep empty spaces at the bottom, and loading the sides, was founded on an entire misapprehension of the problem, and did not have a single pertinent fact that could be logically brought to justify it, so that much talent and money has been spent in hunting myths—an innocent amusement, if it had not led to experiments that have proved fatal to many ships and their crews. For if the weights in the "Captain" had been dropped down into the void space in her bottom, her stability would have been so increased that, in all human probability, her name would still have been on our Navy List, and her crew amongst us.

In one case, twelve vessels were capsized in the same *pampiro* from insufficiency of stability.

The cure is obvious from what has been shown, and that which would produce safe ships that would sail well, carry large engines, with sufficient coals for long distances, and be manageable with all, viz., breadth not to exceed one-fifth of the length, not less than 6 feet of metacentric height (greater if subject to damage or having to carry unusual weight above, such as armour), and a low centre of gravity, and great proportionate displacement, for dimensions, by great proportionate immersion, when admissible, according to the service purposed for them.

Much of the easiness of "Raleigh" arose from the fact that she was immersed nearly 2 feet more than was intended, some of this by 180 tons of ballast placed on her floor, by which her centre of gravity was lowered and her stability increased, she would be a safer and better ship from more ballast.

Nothing will compensate, in certain not uncommon circumstances, for the absence of a low centre of gravity and weight on the floor equal to one-tenth of the nominal tonnage.

The great French architect, Sané, showed that he understood the problem, when he placed large quantities of ballast on the floor of his designs, and designed them to tumble home above.

His ballast in steamers should be substituted by engines.

In conclusion, this new theory of stability in a sea-way, and its alleged effects, no less than the theory of rolling, is in direct contra-

diction to the teaching of facts, and authorities so distinguished as Poisson, Bernoulli, Chapman, Inman, and Mozely; and of living authorities, as Puy de Lôme and Scott Russell, who has steadily opposed this system as erroneous and dangerous.

It is claimed that this is the scientific system and its advocates eminently scientific; but science ignores no factors in any problem, still less does it ignore all influential factors while attributing the observed results as to rolling, to that which is *not* a factor, but merely a mathematical incident!

I should fail in my duty if I did not protest against this system being taught at Greenwich, and more, against ships and their crews being further made the subject of experiments involving so much danger, experiments, the success of which never had a probability, much less any reason to warrant a departure from a long approved and established system!

Captain COLOMB, R.N.: I do not presume to follow the enormous mass of facts and figures that have been put before us; but one of the ships mentioned—the "Audacious"—I happen to have commanded for over three years, and the lecturer has stated that her easiness, absence of rolling, or whatever we may call it, is mainly due to the 360 tons of ballast which had been placed in her. Now, the initial stability of that ship is accordingly small, so small that a few hands passing from one side to the other on her battery will give her a slight list. It is difficult, in fact, to keep her exactly upright. But, on the other hand, the fact remains that, during the time I commanded her I hardly ever succeeded in getting a rolling experiment. I never could ascertain what the period of the ship was, because the rolling was so exceedingly small, generally within one degree, that we could not register. Admiral Fishbourne seems to say that the modern theory tells you that the more you reduce the metacentric height, so much the safer does the ship become. I have never heard that stated except in this theatre.

Admiral FISHBOURNE: I quote from Mr. Froude's own pamphlet.

Captain COLOMB: I have not seen the pamphlet. I have always heard it stated that the readiest way—under conditions—of getting a steady platform for your guns is the reduction of the metacentric height, roughly speaking, and the proposition is not that we gain greater safety by that reduction, but the problem is, how far you can reduce it with safety? There is no question but that in the "Audacious," whatever the cause was, the object was attained. The ship was apparently a perfectly safe ship, and she had this wonderfully steady gun platform.

Mr. W. H. WHITE: Before I make any observations, will you allow me to ask Admiral Fishbourne a question or two as to the figures he has given in the second table on page 9 of proof (202), and the table on page 10 (205), because I shall be guided much in what I have to say by his replies. In the first place I should like to know if the ships named in the table on page 10 have ever been at sea together, and, further, upon what authority the maximum angles of roll, say, for the "Miantonomoh," the "Pallas," and "Penelope" are based? Also, in what publication of my own, the second table, on page 9 of proof (203), with which I am credited—comparing "Prince "Consort," "Miantonomoh," "Sultan," and "Hercules"—can be found?

Admiral FISHBOURNE: I did not say that was your table. The first columns are taken from your book; the third and fourth columns, "Angle of Roll" and "Period," are added by me. I distinctly stated so in my paper. Neither have I represented that the ships in the table referred to have ever been at sea together. The maximum angles of roll for the "Miantonomoh," the "Pallas," and "Penelope" are taken from the Blue Books at different times.

Mr. WHITE: There are two principal sets of observations that I wish to make. First, I must decline to admit, with all respect for the Admiral, that he has fairly represented what we are accustomed to call the modern theory of rolling. In proof

of that, I will refer you to his own statement:—"It is accepted as an axiom by those "who contend for the truth of Mr. Froude's theory, that if a ship's stability or "metacentric height be great, her period of roll will accord with the period common "to waves, so synchronisms and increased angles of roll will be given at each "double swing *till the vessel is rolled over*." The words in italics are those to which I take exception. Mr. Froude never said so, and in his first paper you will find he has stated the distinct contrary. Mr. Froude said that, apart from the effect of fluid resistance, the vessel which fell in with waves having a period equal to her own period would be rolled over; but that in practice the tendency to accumulate rolling would be checked by the influence of fluid resistances, such as the resistance to rolling motion offered by flat surfaces and the frictional resistance of the bottom. If anyone will take the trouble to refer to Mr. Froude's paper, he will find that my statement is correct. He will also find that in the paper which I read two years ago so far was I from giving the tables as positive proofs of the influence of the "periods" of ships upon their behaviour at sea, that I headed those tables with these words:—"General experience confirms the teachings of theory that on the whole the ships "with the longest still-water periods are steadiest in a sea-way." That is all I said, and I guarded myself further by enumerating the three principal influences which govern the ship's behaviour at sea, putting first the period of still-water oscillation, and then the magnitude of the fluid resistance. Those tables were given as illustrations of the general statement that "on the whole ships with the longest still-water period are "the steadiest," and not as exact scientific evidence of a theory. As I stated then, those tables were but selections. Take, for instance, the table for the detached squadron, where the "Raleigh" compares so favourably with the other frigates. I stated distinctly that this table was one of a great many tables of that kind; and I may add that the heavier the weather became, the greater was the superiority of the ship of the longer period. I quite admit the justice of the Admiral's statement that the "Raleigh" had other points of superiority besides her long period; but I contend that a very influential thing in the superior behaviour of the "Raleigh" was her long period. The loss of the "Eurydice" has in some way been connected with the modern theory by the Admiral. Now, she is a vessel built long before Mr. Froude read his paper, and was designed by a gentleman having no knowledge of Mr. Froude's theory. You will find by the evidence given at the court-martial that when fitted as a training-ship she was equipped as nearly as possible as she had been before, so that she was sent to sea in almost the same condition as that in which she had successfully served beforehand. Coming more particularly to the question of fluid resistance, it will be seen that Admiral Fishbourne connects fluid resistance to rolling with the statical pressures on the fore and aft or diametral plane. I take exception to that view entirely, and I think everyone who has studied the subject of motion in a resisting medium will know that the matter is quite distinct from statical pressure. I can give you a very simple illustration. Suppose one takes a circular cylinder, and places it with its length horizontally in the water; you know with what ease it can be made to rotate in the water, like a log of timber, simply because it has only to overcome frictional resistance. But suppose one takes a vessel of triangular cross section having the same draught and longitudinal central section as the circular cylindrical ship, the lateral pressures would be the same on both; but the resistance to rolling would be immensely greater in the vessel with the triangular cross section. In fact, the figures given by Admiral Fishbourne are most misleading as evidence of the resistance to rolling of these different ships. Those resistances to rolling, I submit, are governed by three considerations:—(1) the area of the flat surfaces immersed, the dead-wood, keels, and bilge-keels; (2) there will be the approximately cylindrical parts, which will give frictional resistance; (3) the further element of surface disturbance, which may be very great indeed with vessels like monitors. These are the influences which govern resistance to rolling when associated with the rate at which the rolling motion is performed. It is not a question of statical pressure, it is not a question of depth of immersion into the water. The figures given in the paper have a most formidable look, but one need not be afraid of them. My conclusion as to fluid resistance is therefore as follows:—I fully agree with the Admiral as to the importance of fluid resistance; but I entirely differ from him as to the mode of estimating that resistance. It has always been a principle

with me in studying this question, and attempting to analyze figures, which naval Officers have been kind enough to place at my disposal, never to compare ships which were not exposed, so far as I could learn, to the same conditions of wind and sea. I ask if Admiral Fishbourne's tables on pages 9 and 15 of proof are based on a fair method of comparison, or whether any scientific argument can be based upon them. Moreover, I happen to know that in the "Miantonomoh" they never made an observation except with the pendulum. Admiral Fishbourne has made great fun of our objection to the pendulum as a means of recording rolling; but I ask any naval Officer if he believes the pendulum to be a correct means of recording rolling in a ship, for I never met with the naval Officer who did. Moreover, one has only to turn to the reports of the rolling of the Channel Squadron to find evidence that the pendulum does not give a correct measure of rolling. The "Miantonomoh" is put as rolling ten degrees. I do not know what she rolled, and I defy anybody to say what she rolled. Moreover, I strongly object to being brought forward as an opponent of the "Miantonomoh." I thoroughly believe that she was a ship which did not acquire large angles of oscillation in a sea-way, and there were special circumstances, such as lowness of deck and great quickness of motion, which led me to express long ago the opinion that she ought not to roll heavily in a sea-way. Therefore I object to being represented as an opponent of that class of ship. Admiral Fishbourne has made much of my omission of any reference to the "mass" of ships. Now I beg to state that in obtaining an expression for the period of oscillation for a rigid body the mass does not come in at all, or rather it comes in on both sides of the equation, and therefore disappears; so that the tremendous figures of displacement which appear in the Admiral's tables only have a meaning as they relate to the *distribution* of the weights and the consequent moments of inertia. I thoroughly agree with every word written by the French authority who has been quoted. No truer description could be given of the practice of English naval architects than was given in the letter which Admiral Fishbourne read. One other word I should like to say, and it is on a matter of some importance. In discussions on the safety of the "Eurydice" I find the greatest importance attached to a mode of fixing the position of the centre of gravity, which I look upon as most unsound. A ship has a certain total depth. She has a certain part immersed in the water. The Admiral gives us the position of the centre of gravity in relation to that load water-line. So long as one is dealing with ships which have the same ratio of in-water part to out-of-water part, I have no objection; but directly you alter the ratio—that is, vary the freeboard—that method of referring to the centre of gravity at the load-line becomes most misleading. In the case of the "Eurydice" this was particularly true. Admiral Fishbourne gives a table, on page 10 of proof, showing apparently that the centre of gravity has been lowered in recent ships, fixing that point in relation to the water-line; but any gentleman who has a knowledge of the ships, and takes the total depth—for instance, that of the "Devastation"—from keel to upper deck, and fixes the centre of gravity in relation to that total depth without any relation to the load-line, will find that the centre of gravity in the "Devastation" is not in such an exceptionally low position as would appear from the table. I am sure that Admiral Fishbourne will believe that although I am not convinced by what he has written, I have the greatest respect for his opinions.

Mr. WATT: I agree with what Admiral Fishbourne has said, that is, as far as I am able to follow him. I read in the *Times* newspaper that a member of the Admiralty went down to Portsmouth, and listed the ship with a certain quantity of ballast, and then reported that the stability was perfectly satisfactory. The ship goes to sea and capsizes, for a very obvious reason. I should like to ask Mr. White what is the value of the scientific theory of finding a ship's stability, if she capsizes and drowns all hands?

Mr. CHAS. F. HENWOOD, Naval Architect: I think our thanks are greatly due to Admiral Fishbourne for his admirable paper. I do not think that Mr. White has at all answered the essence of the paper. Some of the details have been criticised by him, but the main points have not been touched. When you are speaking of stability it is neither proper nor right to refer the centre of gravity to the depth of the ship, that is taking it in relation to the upper deck or the keel—that is all very well when you are looking at the centre of gravity in relation to the ship herself: but

inasmuch as stability refers or is relative to the load water-line, or plane of flotation, and nothing else, the plane of flotation is the proper and only basis to which, in such case, the centre of gravity is to be referred. The great difference between the scientific aspect has been referred to, and it is said that the "modern theory" has not been fairly represented; but I do not suppose there is any difference at all in science, because none of us claim to have invented a new science; science is a knowledge of laws obtained by reasoning on combined facts, formulated and tabulated for us by our fathers, and we have learned it in our youth from books: or it means *certainty* grounded on facts and demonstrations. It is, however, the misapplication of science which is the cause of the difference which has arisen between naval architects of the present day. A certain theory was introduced by Mr. Froude, but its supporters are now apparently "backing down" from the original stand-point, and so before long they will, no doubt, come back to the old level, for it is now merely alleged that, "*on the whole*, "ships with the longest still-water periods are the steadiest." That may be so under certain conditions, but that does not prove the theory at all; and I think the facts brought forward by Admiral Fishbourne to-night thoroughly upset the theory introduced by Mr. Froude. We have also been told this evening, that the "Eurydice" was sent to sea in nearly as possible her original state. That may be perfectly true; she was sent to sea I believe practically in the same state as she was originally, but at the time she capsized, she was in a condition in which she had never been before. When she went to sea she had on board a larger amount of consumable stores, and a more numerous crew to consume the stores; and so when she arrived at the back of the Isle of Wight her condition was one in which she had never been in previously. She was then very much lighter, her draught of water was very much less, and her centre of gravity very much higher than it had ever previously been as a frigate. The fact was, that her Officers, who might reasonably have supposed that they had under them the old "Eurydice," had really a very different ship. I am also sorry that Captain Colomb did not give us a little more information with respect to the "Audacious." We should like to know whether she ever got into bad weather.

Captain COLOMB: Very often.

Mr. HENWOOD: Then she is a very remarkable ship, and she equals the "Miantonomoh" in steadiness. Of course we must take these statements as facts, and although they are apparently inexplicable, we must accept them and endeavour to find some explanation.

Mr. WHITE: If the evidence given before the court-martial is examined, it will be seen that Mr. Henwood is mistaken as to the ship having been worse off, as regards stability, when she was rid of her consumable stores than she had been in her previous commissions. I am not giving any information which is not accessible to the public; but happened to be present at the court-martial when distinct evidence to this effect was given by those who should know.[1]

Mr. SCOTT RUSSELL, F.R.S.: I have little to do except to express the satisfaction with which in this Institution I always listen to the knowledge which commanders of ships have acquired in the circumstances in which alone you can judge the good qualities of ships, namely, by long experience of their behaviour at sea. I am delighted to hear that there is such a ship as Captain Colomb has described, that there is a vessel in our possession which, put her under what circumstances you like, will not roll. That I think we should assume as the model ship of the future, and naval architects and sailors could do nothing better for us than to investigate that ship to the very bottom. She is certainly a model ship. Perhaps Captain Colomb must have had something to do with selecting the kind of waves and selecting the particular seas, and selecting the good weather, under which that ship passed those happy three years of her and his life, because I am afraid that whatever "periods of roll" your ships have, they will often meet with waves at sea which will not be very courteous to them, and their periods of roll, and therefore

[1] NOTE.—I here refer to the evidence of Mr. Barnaby (Director of Naval Construction), and of Mr. Robinson, Chief Constructor of Portsmouth Yard.—W. H. W.

I am afraid that the dexterous Captain kept her most cleverly out of circumstances in which she would roll. With regard to Admiral Fishbourne's collection of facts, I think it extremely instructive, because conclusions can be drawn from them extremely different to those which have hitherto been drawn from such experiments. When I was young I was educated in a school of practical construction, which had, as one of its ideas, giving a ship extremely small metacentric height, and those ships, built to meet certain circumstances, not adapted to a theory at all, were a source of great danger and sorrow to all who had to do with them. I call a ship of small metacentric height, I am afraid, offensively, a "crank" ship, and a "crank" ship may and will be, in certain circumstances, a very gentle roller, and may have a very stable platform; therefore if the circumstances are wisely chosen by a very clever sailor, she will have most wonderful qualities; but put her out of those conditions, and according to my experience, you will find her the worst and most dangerous ship you ever saw. I therefore call attention to the fact that in every ship you build, you must provide two kinds of stability for two totally different sets of circumstances. This low stability is delightful for smooth water, for gentle, moderate, and well regulated waves, such as you could manage to have in a nicely sheltered sea; but I put it to the profession whether they attach the slightest value to a sea-going ship, though her behaviour is ever so good in smooth water, if, when it comes to heavy cross seas and heavy storms, she is incapable of maintaining her position on the sea. That is the case of these small metacentric height ships in such groups of waves as I have witnessed in the Bay of Biscay. If Captain Colomb had brought the "Audacious" safely through such a sea as that, it would have been a triumph for the Captain, and for the ship. I think Admiral Fishbourne is quite right in saying that the low metacentric height is a false light which has been by some constructors blindly followed, and has led us into various mistakes. Old constructors, such as the eminent Sané of the French Navy, and eminent Spanish writers on this subject, and other eminent naval constructors, have handed down to us sound principles for the construction of ships with seaworthy qualities, and with the right kind of stability; and I sit down by stating that there are two radically different sorts of stability, that the one is the stability of smooth water, and the other the stability in rough water, and that the kind of stability against which Admiral Fishbourne has spoken so strongly, is the kind of stability which is good for smooth water and fair weather, but utterly ruinous when you come to ships whose test of utility is to be their seaworthiness, their stability, and good qualities in a storm.

Captain CURTIS: It seems to me that, with a low metacentre, you could not work your ship off a lee shore. Supposing any of our cruizers got short of coal, and had to work off a lee shore, I do not know how they would do it. With regard to the sails, I can quite understand a vessel rolling slowly, but I cannot understand how the "Audacious" would act under her double-reefed topsail, as compared with an ordinary frigate—whether it would affect her listing.

Captain COLOMB: I can tell you how it was in the "Audacious." When you could just carry double-reefed topsails, and were obliged to take the top-gallant sails in, just at that point the ship heeled 8 degrees.[1]

Captain CURTIS: As compared to an ordinary frigate, I mean.

Captain COLOMB: I could not say, because there was no frigate with us in the same position. My own impression is, that the ship was remarkably stiff after the first few degrees of heel, and so strongly have I felt this, that I have officially suggested that the ballast should be removed. No doubt, the gallant Admiral will tell you the only good thing about her was the ballast. I should not like it to go forth to the public that Her Majesty's ship "Audacious" was under my control in any way as to avoiding or getting into any sea. As it happened, she was several times in pretty heavy seas, and the absence of rolling was remarked upon by us all.

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[1] NOTE.—I find, on reference to my diary, the following note on the occasion referred, August 3rd, 187ö:—"Ship under plain sail, less royal, flying jib and "spanker, wind abeam; went 8·2! Wind freshened; took in two reefs of top-"sails. . . . . Beam sea. . . No rolling. 4° to 6° heel, with double-reefed "topsails and courses."—P. H. C.

On one particular occasion, I remember that she broached to after running before the wind, her behaviour was then so remarkable, and she was so exceedingly steady, that the Admiral made a special report to the Admiralty on the subject. The "Iron Duke," her sister vessel, was certainly in one, if not two, typhoons in the China Sea. Such circumstances ought to try the ship.

Mr. SCOTT RUSSELL: I am delighted to withdraw my observations in which I gave the gallant Officer all the credit of having arranged for the proper behaviour of the ship, and I must attribute the credit to the excellent ballast. It is just what I should have recommended in the circumstances of such a ship, to correct completely all her bad qualities; they were so corrected, and I am more content than before.

Admiral FISHBOURNE: The description Captain Colomb gives of the "Audacious" lowers her in my estimation very much. It is very clear that her condition is very nearly approaching to indifferent stability. He says, a very few men going on one side of a 6,000-ton ship incline her, and she is so indifferent that she does not seem to care to move in any direction. Now, I say, there are circumstances in which she may be placed, for instance, at the Cape of Good Hope, on the Agullas bank, with a current running to windward in a gale; she would be in excessive danger of tumbling over one of those wall seas found there. The only reason why she appeared to have great stability was the excessive disproportion between her masts and her hull—a 6,000-ton ship with the masts of a 2,000-ton frigate. The "Nerbudda," a vessel of great breadth of beam and great initial stability, was tumbled over on one of those wall seas. She was no doubt light, and out of provisions, but the same thing might occur with the "Audacious." As for carrying sail, it could be of no use to her. And more, she could not steer; and this is an essential quality. Mr. White seems to think that I have misrepresented the new theory. I suppose Dr. Woolley understands it. He said Mr. Froude has established that, for safety, it was necessary that a ship should have a very little initial stability. I can understand this in no other sense than this, that he meant to say that, by a series of synchronisms, vessels would be rolled over if they had a large amount of initial stability.

Captain COLOMB: Where is it to be found?

Admiral FISHBOURNE: I quoted it in my last paper. Of course, if Mr. Froude abandons it, I am content, and am only happy that he should do so.

Mr. WHITE: In Mr. Froude's first paper, to which, I believe, the Admiral is referring, those statements will be found which I referred to as to the effect of resistance. The two things are mentioned—unresisted rolling, which would give the danger of upsetting, but limited by resistance.

Admiral FISHBOURNE: I have quoted his exact words, as given in a note written by himself to myself, and substantially the same will be found in his pamphlet, which I have also. I will read it:—"The effort of stability is the lever by which a wave forces "a ship into motion; if a ship were destitute of this stability, no wave that the "ocean produces would serve to put her in motion, whether that stability were due "to a broad plane of flotation, or to deeply stowed ballast." If he does not mean that now, it would be an act of humanity to withdraw it, because its tendency has been to induce the Constructors of the Navy to reduce the stability of ships to a degree that is absolutely unsafe. I have no hesitation in saying that, if, in a crisis, we had put 2,000 men upon each one of those ships mentioned, and they had gone out, they would have tumbled them out into the sea—not like the mud barges, to come back for another cargo, for these ships would have turned right over and have gone down. As to this table to the left, I have brought these facts into contiguity for convenience. The story of the "Eurydice" is too long to go into now. I hope at some future time to be able to show what was really the cause of her capsizing. I admit that the court-martial had no right to assume anything else than that she had enough stability, because the ship was given over to its Officers; with this assurance, therefore, they were not to blame in assuming that she had sufficient stability; that she had not, the fault did not lie with the Officers. It was not a court-martial to try the Construction Officers of the Admiralty, though I believe they ought to be put on their trial as well as Officers, when ships are lost and men are drowned. As to resistance to rolling, it stands to reason, if you are rolling a

cylinder round a fixed axis, there is only the friction; but that is a totally different thing to a ship. If the difference of immersion makes no difference, why have they put bilge keels? Every argument for them is in favour of my argument. Mr. White has not objected to a single principle that I have brought forward; he has merely referred to technical details of no importance. My argument as shown in the diagram, is, that it is the wave which has brought the ship into that position, and not stability. Stabilty is an opposing motion till the ship is on the back roll; then the two concur, till a new lever is brought out in the opposite direction to resist her further inclination in that direction. Mr. White admits the influence of greater mass in his own paper. How then object? He also will find in Mr. Reed's work, "Our Ironclads," such records as—ships rolling according to their masses the heaviest, slowest, and least.

The CHAIRMAN: We must all feel thankful to Admiral Fishbourne for his able and well-considered paper; and I think I may take it for granted it is your wish that I should convey to him your thanks.

NAMES OF MEMBERS who joined the Institution between the 1st January and the 31st March, 1879.

LIFE MEMBERS.

Blagrove, H. J., Lieut. 13th Hussars.
Powell, C. H., Lieut. R.M. Light Infantry.
Anstice, J. A., Capt. 6th Salop Rifle Vols.
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LATE ADDITIONS TO THE FRENCH NAVY.

IN the year 1872 a programme of reconstruction of the *Matériel* of the French fleet was drawn up by Vice-Admiral Pothuau, at that time Minister of Marine. The Admiralty Council having expressed a favourable opinion of it, it was submitted to, and passed by the National Assembly, by which body it was understood to be limited to what was strictly necessary. The Naval Board of Construction (*Conseil des Travaux*), having been called upon to suggest improvements in the proposed constitution of the new fleet, examined the different designs submitted, and recommended an increase in the speed, and the power of the ordnance to be carried; with that view adding to the horse-power of the engines, to the dimensions of the hulls and to the thickness of the armour-plates. This resulted in substituting for the individual ships at first proposed others much more costly, thereby causing in the Estimates of the present time a considerable advance on those of 1872. The cost of the fleet, as proposed in the programme of that year, was first estimated at £19,267,240; but in 1876 it was ascertained that the sum required for the work already done and for the completion of the improved types of ships, as recommended, would amount to at least £24,934,000. The programme put forward in 1872, with the estimate of the money necessary te carry it out, and that of the sums afterwards found requisite, follows :—

PROGRAMME OF 1872.

Ships.	Number.	Estimate of 1872.	Estimate of 1876.
		£	£
Iron armour-clads.—1st rate	16	5,307,520	6,624,000
2nd rate	12	2,596,320	3,576,000
Iron coast-defence vessels.—1st rate	10	2,005,600	2,500,000
2nd rate ..	10	1,644,400	2,040,000
Cruizers.—Iron, wood-sheathed	8	1,654,080	2,428,800
Coppered	8	915,520	1,321,600
Wood, 3rd class	18	1,026,720	1,296,000
Despatch vessels (former 2nd class do.) .	18	511,920	640,800
Gunboats	32	559,360	704,000
Transports.—Horse transports (iron) ..	10	1,329,200	1,660,000
For colonial service (iron) ..	5	664,600	830,000
Store ships (iron)	10	436,000	544,000
Other craft	60	616,000	768,000
Totals	217	19,267,240	24,933,200

As a first step in the reconstruction which it was decided to complete, a Committee of Officers and dockyard officials made an inspection of the existing ships; and from their report the Board of Admiralty considered it right that a certain number should be removed from the Navy List, and that others of wood should be utilised as transports and store-ships. Between 1872 and 1875 fifty-four vessels, condemned by the Admiralty Board, were broken up; and in 1878 fifteen others were in course of demolition; attempts to sell them having failed.

In the years 1872 and 1873 twenty ships, of which the 1st rate armour-clad "Redoutable" and the 1st class cruizers "Tourville" and "Duquesne" formed a part, were laid down from designs by the most eminent constructors, who had been guided in their production by the progress made in England. Between 1873 and 1878 there were begun thirty-nine vessels of different classes, such as the 1st rate armoured-ships "Devastation," "Foudroyant," and "Duperré;" whilst in ships already in progress improvements adopted in England, Germany, and Italy were introduced. The resources of private industry were taken advantage of as far as possible; and the construction of one 1st rate armour-clad, one 1st class cruizer, and several other vessels, was intrusted to commercial building establishments.

The following tables, extracted from official returns, presented to the Assembly when in session last year, will convey an idea of the work which has already been accomplished and that which remains to be done in the renewing of the French fleet. (See pp. 222, 222.)

In order to estimate the amount of work which the completion of the programme as given at the beginning of this paper requires, and of the progress which will be indicated in tables to follow, it should be noted that in the above list, there appears the name of only one

SHIPS FINISHED OR LAUNCHED FROM JANUARY 1st, 1872, AND MAY 1st, 1877.

Classes and Names.	Dis-placement.	Horse-Power. (Nominal).	Ordnance. Rifled guns.							Thickness of Armour at the Water-line.	Time from Laying down to Launching.	
			10½ in.	9½ in.	7¾ in.	6¼ in.	5½ in.	Light.	Total.			
Armour-clads—	Tons.									ins.	years.	months.
1st rate — Redoutable	8,836	1,500	8	..	..	..	8	..	16	14	3	4
1st rate — Friedland	8,823	950	8	..	..	..	8	..	16	8	6	9
1st rate — Richelieu	8,417	1,000	6	5	..	..	2	10	23	8¾	5	0
1st rate — Colbert	8,314	1,000	8	1	..	..	6	..	15	8¼	5	2
1st rate — Trident	8,314	1,000	8	1	..	..	6	..	15	8¾	6	6
1st rate — Suffren	7,600	950	4	4	..	..	..	6	14	8	4	4
2nd rate — Victorieuse	4,214	575	..	6	1	..	6	..	13	6	5	9
2nd rate — Triomphante	4,214	575	..	6	1	..	6	..	13	6	7	0
2nd rate — La Galissonnière	4,154	500	..	6	..	..	..	..	6	6	3	10
Armoured Coast-defence vessels—												
1st rate. Tonnerre	5,584	900	2	..	..	..	..	..	2	13	2	7
2nd rate — Tempête	4,523	400	2	..	..	..	..	..	2	13	3	8
2nd rate — Bélier	3,590	530	..	2	..	..	..	..	2	8¾	4	10
2nd rate — Bouledogue	3,510	530	..	2	..	..	..	..	2	8¾	6	3
2nd rate — Tigre	3,602	530	..	2	..	..	..	..	2	8¾	3	6
Gun-vessels—												
Crocodile	460	100	..	..	1	..	..	2	3	..	1	1
Lionne	460	100	..	..	1	..	..	2	3	..	1	0
Cruizers—												
1st class — Duquesne	5,522	1,800	..	..	7	..	14	..	21	..	2	9
1st class — Tourville	5,521	1,806	..	..	7	..	14	..	21	..	2	2

SHIPS FINISHED OR LAUNCHED FROM JANUARY 1ST, 1872, AND MAY 1ST, 1877.

Classes and Names.		Displacement.	Horse-Power. (Nominal).	Ordnance. Rifled guns.							Thickness of Armour at the Water-line.	Time from Laying down to Launching.	
				10½ in.	9½ in.	7⅞ in.	6½ in.	5½ in.	Light.	Total.			
Cruizers—		Tons.									ins.	years.	months.
2nd class	Duguay-Trouin ..	3,190	875	..	..	..	5	4	..	9	..	3	11
	Champlain	1,930	450	..	..	..	1	9	..	10	..	4	8
	Dupetit Thouars ..	1,930	450	.	..	..	..	10	..	10	..	7	5
	Fabert	1,960	450	..	..	..	..	8	..	8	..	6	3
	Laclocheterie ..	1,960	450	..	..	..	..	10	..	10	..	4	4
	Seignelay	1,960	450	..	..	..	..	8	..	8	..	7	4
3rd class	Rigault de Genouilly	1,640	450	..	..	..	..	8	..	8	..	3	1
	Beautemps-Beaupré	1,270	230	..	..	..	1	5	..	6	..	4	7
	Duchaffaut	1,289	250	..	..	..	..	6	..	6	..	4	2
	Hugon	1,290	230	..	..	..	1	5	..	6	..	4	9
	Leguelen	1,280	250	..	..	..	..	6	..	6	..	4	1
Gun Despatch vessels—													
Bisson		833	175	..	..	..	..	4	..	4	..	1	2
La Bourdonnais		833	175	..	..	..	..	4	..	4	..	1	7
Boursaint		750	150	..	..	..	1	2	..	3	..	4	3
Bouvet		750	175	..	..	..	..	4	..	4	..	3	5
Transports—													
Large troop ship, Annamite ..		5,430	650	..	..	..	..	2	..	2	..	3	9
Store ship, Caravane		2,018	150	..	..	..	..	2	..	2	..	6	7
Despatch vessels	Vire ..	1,682	150	..	..	..	..	6	..	6	..	3	10
	Sendre ..	1,684	150	..	..	..	..	2	4	6	..	4	0

Besides 12 gunboats, sailing-vessels and other small craft.

Note to last column of the above Table.—From the launch to the final trial trip, a period of a year and sometimes more for large ships, and of six months for small, generally elapses.

SHIPS BUILDING AT THE BEGINNING OF 1877.

Classes and Names of Ships.		Dis-placement.	Horse-Power.	Ordnance. Rifled Guns.								Thickness of Armour at Water-line.
				above 12¾ in.	12¾ in.	9½ in.	7¾ in.	6⅓ in.	5½ in.	Light.	Total.	
Armour-clads—		Tons.	Nominal.									in.
1st rate	Amiral Duperré	10,487	1,500	4	..	..	..	..	15	..	19	22
	Dévastation	9,606	1,000	4	2	..	..	..	8	..	14	15
	Foudroyant	9,606	1,500	4	2	..	..	..	8	..	14	15
2nd rate	Bayard	5,881	800	..	..	4	1	..	6	..	11	10
	Turenne	5,881	800	..	..	4	1	..	6	..	11	10
	Triomphante ..	4,214	575	..	..	6	1	..	6	..	13	6
Coast-defence vessels—												
1st rate	Fulminant	5,584	900	2	..	..	..	..	..	..	2	13
	Furieux	5,584	900	2	..	..	..	..	..	..	2	13
2nd rate	Tonnant	4,523	400	2	..	..	..	..	..	..	2	13
	Vengeur	4,523	400	2	..	..	..	..	..	..	2	13
Gun-vessels—												
Lutin		460	100	..	..	..	..	?1	2	..	3	
Lynx		460	..	..	..	..	..	?1	2	..	3	
Cruizers—												
2nd class	Duguay Trouin ..	3,190	875	..	..	..	..	5	6	..	11	
	D'Estaing	2,550	650	..	..	..	..	..	15	..	15	
	Forfait	2,250	650	..	..	..	..	..	15	..	15	
	Lapérouse	2,250	650	..	..	..	..	..	15	..	15	
	Magon	2,250	650	..	..	..	..	..	15	..	15	
	Monge	2,250	650	..	..	..	..	..	15	..	15	
	Nielly	2,250	650	..	..	..	..	..	15	..	15	
	Villars	2,250	650	..	..	..	..	..	15	..	15	

SHIPS BUILDING AT THE BEGINNING OF 1877.

Classes and Names of Ships.	Dis-placement.	Horse-Power.	Ordnance. Rifled Guns.								Thickness of Armour at Water-line.
			above 12¾ in.	12¾ in.	9½ in.	7¾ in.	6½ in.	5½ in.	Light.	Total.	
	Tons.	Nominal.									
3rd class, Eclaireur	1,640	450	..	..	..	..	..	8	..	8	
Gun Despatch vessels—											
Chasseur	833	175	..	..	..	..	..	4	..	4	
Hussard	833	175	..	..	..	..	..	4	..	4	
Lancier	833	175	..	..	..	..	..	4	..	4	
Parseval	833	175	..	..	..	..	..	4	..	4	
Voltigeur	833	175	..	..	..	..	..	4	..	4	
Transports—											
Large troop-ships { Mytho ..	5,430	650	..	..	..	..	..	2	..	2	
Large troop-ships { Shamrock ..	5,430	650	..	..	..	..	..	2	..	2	
Large troop-ships { Tonquin ..	5,430	650	..	..	..	..	..	2	..	2	
Despatch vessels { Allier.. ..	1,682	175	..	..	..	..	..	6	..	6	
Despatch vessels { Drac	1,682	175	..	..	..	..	..	6	..	6	
Despatch vessels { Niévre ..	1,682	175	..	..	..	..	..	6	..	6	

sea-going armour-clad, the "Redoutable," whose hull is not of wood. (See pp. 223, 224.)

Of the sea-going armour-clads in this list it should be remarked that all, except the "Triomphante," have iron, or iron and steel hulls. At the same date as that of the foregoing list, twelve vessels of various classes were launched and being completed for service. The subjoined table shows the numbers and descriptions of ships necessary to be gone on with in 1877 and 1878, to complete the programme already mentioned. (See p. 226.)

Besides 9 large troop ships and 10 small vessels. Torpedo-boats are not included in the above. All the armoured ships are to be of iron or steel. The date of the final completion of the programme is fixed at 1885, by which time it is probable that wooden armoured vessels will have disappeared from the French sea-going fleet as nearly as they have from that of Great Britain.

Of the great sums, which the determination to complete the reconstruction of the floating *matériel* rendered it necessary to expend, it was found that a large portion was due to the cost of armour-clad ships, caused chiefly by the obligation to increase their dimensions that they might bear the thicker armour which naval progress rendered requisite. It proved impossible to economise by refraining from laying down heavy fighting ships; and it was accepted as demonstrated that the 1872 programme contained a statement of the minimum strength which it would be safe to allow the Navy to stand at.

Building might be made to proceed slowly; but still building of vessels of the sort mentioned must be permitted to be taken in hand, in order that as each particular one of the old type should be removed from the list one of the new design might be ready to take her place. For it must be recollected that of the ships afloat at the time when the reports, from which quotations have been made, were presented many had been laid down during the Empire, and, being of wood, a considerable number of them had undergone much deterioration. So that the floating effective of 1878 appeared to be nearly the same as that of 1872; as in spite of additions to it by completing vessels begun in 1869 and 1870 there had been some important losses, and the whole fleet of the former period had begun to show signs of wear and tear. The reconstruction of the Navy, therefore, was so far aided as it were by natural causes; and a proportion of the older vessels disappears from its list every year. Of 220 ships in existence at the beginning of 1873 it is anticipated that 127 will have been replaced by new ones in 1885; the date by which the proposed reforms are to be completely realised, when the whole fleet will be composed of vessels of which the designs are in accordance with the progress made in the Naval Art.

Admiral Pothuau, the Minister of Marine, said in a speech in the Assembly during the session of last year, "We have proposals for re-
" constituting the fleet which date from 1872, which is sufficient for
" our wants. Followed up vigorously, as it is our firm intention it shall
" be, it will be realised, at the latest, in 1885. The comparison of our
" Navy with those of Foreign States proves incontestably that it holds

Classes of Ships.		Dis-placement.	Horse-Power.	Ordnance. Rifled Guns.									Thickness of Armour at the Water-line.
				above 12¾ in.	12¾ in.	10½ in.	9½ in.	7¾ in.	6¾ in.	5½ in.	Light.	Total.	
		Tons.	Nominal.										in.
4 Armour Clads, 1st rate	1 ..	10,500	1,800	4	..	..	..	..	..	..	..	..	22
	3 ..	31,500	5,400	12	..	..	..	..	..	..	..	..	22
6 ,, ,, 2nd rate	1 ..	5,881	800	..	..	..	4	1	..	6	..	11	10
	5 ..	29,405	4,000	..	..	..	..	5	..	30	..	55?	10
8 Coast-Defence vessels	1 ..	5,500	1,200	1	..	..	..	..	..	..	..	1	24
	7 ..	38,500	8,400	7	..	..	..	..	..	..	..	7	24
28 Gun-vessels	1 ..	460	100	..	..	..	..	1	..	..	2	3	
	27 ..	12,420	2,700	..	..	..	..	27	..	..	54	81	
2 Cruisers	1 ..	3,500	800	..	..	..	..	2	..	12	..	14	
	1 ..	3,500	800	..	..	..	..	2	..	12	..	14	
5 Despatch vessels	1 ..	830	175	..	..	..	..	..	..	4	..	4	
	4 ..	3,320	700	..	..	..	..	..	..	16	..	16	

"the second place amongst the Naval powers of Europe; but it also "proves, by all the efforts which are being made around us, the "necessity of voting sufficient funds for the Navy to prevent its losing "this rank. It is certain that, whilst the Powers which surround us "are consistently persevering in this path (that of building powerful "ships), it would be the height of imprudence for us to have only "ships of moderate tonnage, without armour, and carrying guns of "small power. All this certainly costs money; but how can we do "otherwise? As long as our neighbours continue their course, we "must imitate them. . . . No doubt Naval *matériel*, owing to "the rapid transformations of the present day, is likely to be sur-"passed every year. Its maintenance in good condition ought to be an "object of constant anxiety to the administration of the Navy, so "that it may always be kept fit for service. We must also reflect "that, if numerous maritime armaments have taken place in Europe, "our neighbours would have not only their new ships to put in line, "but would also be able to have recourse to some of their older ones. "The Power which shall have had the wise foresight to take care of "its *matériel* and to keep it in the best possible state, will be that "which will take the sea under the most favourable conditions."

The important additions which these reforms have made and are still making to the Navy of France will best appear from descriptions of the more important of the new classes of vessels built in the establishments belonging to the Government and in those of private individuals. Beginning with the armour-clads, the "Amiral Duperré" may be taken first. This vessel was laid down at the building-yard of La Seyne in Toulon Roads, belonging to the company of the *Forges et Chantiers de la Mediterranée*, in December, 1876, from designs by M. Sabattier, Constructor (*Directeur du Matériel*) at the Ministry of Marine. She is to be completed in March, 1880. She is the largest vessel in the French Service, and is armoured, at the water-line, from stem to stern, the belt extending from the extreme point aft to the end of the ram. There is an armoured deck placed level with the upper edge of the water-line belt. Her extremities are divided into a large number of water-tight compartments, in addition to being protected by armour which varies in thickness from 12 to 22 inches. The system of construction resembles that adopted in H.M.S. "Inflexible;" but it is claimed that it is stronger. With the exception of the stem, stern-post, and skin plating, the hull is built entirely of steel. These are her principal dimensions—

Length between the perpendiculars at the water-line	319 ft.
Breadth (extreme)	67 ft.
Mean draught of water	25 ft. 9 in.
Displacement, tons	10,487.

The hull has a double bottom; it is divided into two parts by a longitudinal bulkhead; and contains nearly two hundred water-tight compartments and cells. The armour amidships and near the machinery and magazines is 22 inches thick, the height of the midship portion

is 8 feet. The stem is of wrought iron in the form of a ram and receives the butts of the water-line armour-plates, the lower edges of which are brought down forward nearly 10 feet below the water-line to the very point of the ram. The rudder can be worked by hand or by steam.

The peculiarity of the arrangement of the armour-plating is that—with the exception of the belt—there is no side armour. Fourteen $5\frac{1}{2}$-inch (14 c.m.) rifled guns are mounted on the broadside on the main deck, but are unprotected. On the upper deck there are four *barbette* turrets, of which one is placed each side before the funnels, protruding sponson fashion beyond the edge of the deck; one stands in the middle of the quarter-deck, and one is abaft the mizenmast. These turrets are all armoured, and in each is mounted a $13\frac{1}{2}$-inch (34 c.m.) breech-loading rifled gun. The projection of the side turrets allows of a line of fire parallel to the keel. All four have a thin vertical screen of iron running round a portion of their circumference. In the two foremost ones this is on the inside; in that on the quarter-deck on the after side; and in the one abaft the mizenmast on the foremost side. The interior of the turrets is sheltered from a plunging fire from rifles or machine guns in tops by bridges or hurricane decks, which run forward and aft from the mizenmast so as to cover the two after ones, and athwartships before the funnels so as to cover those at the sides. In the fine model of this vessel exhibited at the Paris Exhibition in the Champ de Mars, there was a gun pointed right ahead through a port under the topgallant forecastle, but it is not mentioned in any list of her armament.

The engines were made at the Menpenti works, belonging to the builders of the hull. They are two separate engines, each working a screw; their united horse-power is 6,000, which can be raised to 8,000 when recourse is had to forced draught for the furnaces. These engines are vertical and on the compound system; they have three cylinders working a main shaft with three cranks. Four independent groups of boilers, each composed of three cylindrical bodies with three furnaces, supply steam to the engines. The principal dimensions of the engines and boilers are as follows:—

Diameter of large cylinders	$78\frac{3}{4}$ inches.
„ small „	61 „
Stroke	1 ft. 3 in.
Number of revolutions for 3,000 H.P.	70.
Grate surface	774 sq. ft.
Heating do.	18,754 „

The "Amiral Duperré" is one of the few armoured ships of the French Service which have not been built in some one or other of the Government dockyards Those of which descriptions follow are the work of the artisans in the pay of the State. The "Redoutable" has been already mentioned. She was designed by M. de Bussy, and was laid down in 1872. Her hull is constructed of iron and steel. "She "is the first ship in which steel has been used to a considerable "extent for the frames, interior girders, &c." The skin plating is iron.

The weight of the hull, including the backing of the armour, is 3,845 tons; that of the armour, 2,360 tons. The principal dimensions are:—

Length at the water-line	312 feet.
Breadth	64½ „
Mean draught of water	23 ft. 9 in.
Displacement, tons	8,796.

The thickness of the armour-plating is 14 inches at the water-line; that of the armoured deck is 2⅓ inches. The armour is arranged in a water-line belt running right round the ship, and—as in all the later French armour-clads—brought well down over the point of the snout or ram. In the central part of the ship an octagonal battery, from the main to the upper deck, is built. The sides, before and abaft this battery, tumble home considerably, and are also much retired as they near it from the extremities. This permits of a fore and aft fire from the protected guns inside the battery. The latter bears some resemblance to the upper battery of the "Audacious" class in the British Navy, but the faculty of firing parallel to the line of keel is secured in the French ship by the tumble-home of the ship's sides, and not by the projection of the battery beyond them, as in the English vessel. On the deck above one heavy gun is mounted on each side, protected apparently by a thin screen of iron, over which it fires *en barbette*. In the model of this vessel, exhibited at Paris last year, there was a barbette tower shown on the upper deck, abaft the mizenmast, and the bulwarks all round the stern were fitted to let down, so as to be clear of the fire of the gun which it carried. This gun does not appear in any official list of her armament; and it may have been added, or removed, since the first approval of her design. The guns in the battery are four in number; their calibre is given in one list as 12¾ in. (32 c.m.), and in a later one as 10¾ in. Those mounted *en barbette* on the battery are apparently of the same calibre as the last. There are also eight 5½ in. (14 c.m.) guns distributed about the quarter-deck and forecastle. A certain amount of protection to the upper-deck heavy guns is given by the arrangement of the covering bridge. Like the "Amiral Duperré" the "Redoutable" has three square-rigged masts.

The engines were constructed at the celebrated Creuzot Works. They are on the compound system, and have six horizontal cylinders. The boilers have forty furnaces, of which the grate surface is 787½ sq. feet. The horse-power to be developed is 6,000, which, at the draught of water given above, should give a speed of 14·5 knots. The ship has only a single screw, and carries 620 tons of coal.

The "Dévastation," designed by M. de Bussy, is an enlargement of the preceding plan. The hull is built of steel, but the skin plating is of iron. The weight of hull is thus only 3,735 tons, of the armour 2,836. The dimensions of this vessel, and those of the "Foudroyant," on the same plan, are:—

Length at the water-line	312 feet.
Breadth	67 „
Draught of water	24 „
Displacement, tons	9,606.

The thickness of the water-line belt of the "Dévastation," which ends at the quarter, being apparently continued across the ship, is 15 inches; of the sides of the battery, 9¼ inches; and the armoured deck is plated with 2¼-in. iron. The guns are mounted as in the "Redoutable," but there is no *barbette* turret abaft. The official description of the vessel gives the calibre of the four battery guns as 12¾ in. (32 c.m.); that of the two guns above it as 9¾ in. (27 c.m.); and that of the light pieces on the quarter-deck and forecastle as 5½ in. (14 c.m.).

There are two screws driven by separate engines, on the Woolf system, with three cylinders each. The machinery is being made at the Government factory at Indret. The indicated horse-power anticipated is 6,000; and the speed 14·2 knots. Forced draught can be arranged to increase the power developed to 8,000. A supply of 560 tons of coal can be carried. The boilers are elliptic. The rudder is of the double form common in the newer French armour-clads. This ship, like the preceding one, has a very flat floor, a shallow central keel, and two side keels extending from a point below the mizenmast to one near the foremast.

The "Dugueslin" represents the class of armour-clads of the second rate, and was designed by M. Lebelin de Dionne, Naval Constructor. She was begun in 1876. The hull is built of steel and is cased with wood. Its weight is 2,550 tons, and that of the armour 1,510 tons. Her principal dimensions are the following:—

Length at the water-line	266 feet.
Breadth	57 „
Mean draught of water	23 ft. 4 in.
Displacement, tons	5,882.

The armour is confined to a belt, and to the covering on the sides of four barbette turrets. The greatest thickness of the former is 10 inches, of the latter 8 inches. There is an armoured deck, 2 inches thick. Four heavy guns are carried, one in each of four barbette turrets, of which two are in the forepart of the ship, slightly projecting beyond the sides, immediately abaft the fore-rigging. These turrets are well sheltered from plunging fire of musketry or Gatlings by the bridge, which runs across the ship immediately above them. One gun is mounted in a central turret, quite uncovered, between the mainmast and the funnel. The fourth piece is in a turret, the sides of which rise to a level with the poop-deck, in which it seems sunk as a well. These guns have a calibre of 9½ in. (24 c.m.). Under the topgallant forecastle a 7½-in. (19 c.m.) gun is mounted, which can be fired right ahead. Six light pieces are distributed on the main-deck, a considerable distance apart, and are not protected by armour. The "Dugueslin" is a full-rigged brig. Her ram takes the form of a snout, tipped with a metal casting of extraordinary length. She is propelled by two four-bladed screws, driven by engines with three vertical cylinders each, fabricated at Indret. They are on the compound system. The shafts protrude for a great length beyond the brackets under the counter which supports the casings in which they

work. The boilers are cylindrical, with a grate surface of 414 sq. feet. The engines should indicate 4,100 horse-power; and a speed of 14 knots should be attained. The quantity of fuel that can be stowed is 400 tons. The vessel has a moderately fine section, and is fitted with a central keel.

A feature of the equipment of the sea-going armour-clads of the French Navy, is the arrangement of the towing torpedo. Though the principle is the same, this weapon does not resemble, in outward appearance, that invented by Captain Harvey. It is an elongated cylinder, champfered away at the ends, to ensure divergence. The attachment to the tow-line is a span of two legs. The torpedo is usually slung to two light davits or derricks stepped somewhat low down on the ship's side, abaft the main rigging; sometimes the torpedo lies on a kind of bill-board, from which it is moved into a position ready for slipping, by inclining the davits outwards; or it is ejected clear of this by tumblers, somewhat as fitted with sheet-anchors. It is hung by slips to the davits, the foremost one of which is longer than the other, so that the head of the torpedo is directed outwards, and the proper divergence quickly attained. The tow-line is led from forward, it usually comes in on the top-gallant forecastle, close to the deck, and is thus kept low enough to clear the fire of the battery guns. From that point it goes through a leading block, as near to the eyes of the fore rigging (inside), as the futtock shrouds permit; and thence through another leading block to a third on the upper deck, abaft the foremast, some feet farther amidships than the bulwarks. It goes from there to the breakwinches, which can usually be placed well under cover, being sheltered laterally by the barbette turrets, and overhead by the bridge or flying deck for conning from. There is apparently no dipping line; but as the present form of towing torpedo has been some years in use, it must be supposed that the simple arrangement just described has been found sufficient to manœuvre it properly.

The positions in which the boats of the new French armoured sea-going ships are hoisted up have evidently been selected with especial care. No davits have been allowed to be fixed so as to seriously impede the fire of the guns. In some ships this difficulty has been completely surmounted; in others less effectually. But in those in which the line of fire is least clear, it is plain that the distribution of the boats has been arranged on a systematic plan. Ingenious arrangements are made for getting both boats and davits out of the way of the guns when necessary, and no rough-and-ready methods of doing so have to be improvised by the crew when clearing for action.

The "Tourville" is an important representative of the new unarmoured cruizers of the first class. This ship was laid down at the La Seyne building-yard of the *Forges et Chantiers* Company, in August, 1873, from plans by M. Lebelin de Dionne. She was launched in February, 1876, and was handed over to the dockyard authorities at Toulon, in the month of June following. She is built on the composite system; the frames, beams, decks, and skin plating being of iron. The plating is covered with two thicknesses of teak, and the bottom is

sheathed with copper. The stem and the stern-post are of metal. Her principal dimensions are :—

Length (from rudder-head to point of ram)	340 feet
Breadth	50 „
Mean draught of water (load)	22 „ 7 in.
Displacement, tons	5,670.

The rig is that of a full-rigged ship. The fore and mizen shrouds are set up in-board; it is not clear why the main should not be arranged in the same manner. There are two funnels, the after one of which is so close to the mainmast, and is surrounded by four ventilating cowls of such great size, that the mainsail could only be set rarely. The ram-shaped bow is highly elongated. Three guns are carried on each side of the upper deck on protruding sponsons, from which they are fired *en barbette* over low bulwarks; still more reduced in height by being cut away beneath the chase of each piece. The increased arc of fire, obtained by these projecting platforms, is in some cases neutralised by the position of the davits, which, even when turned down, and placed fore and aft for action, must interfere with the fire of the adjacent guns. The crews working the latter are altogether without cover. One gun is carried under the top-gallant forecastle, and can be fired in a line with the keel. All the above are of $7\frac{3}{4}$-inch (19 c.m.) calibre. On the main deck 14 $5\frac{1}{2}$-inch (14 c.m.) guns are carried. The height of the lowest port-sill above the water-line is 10 feet.

The machinery was constructed at the Company's works at Menpenti. On the trial-trip the indicated horse-power was 7,340. The engines are divided into two distinct parts, each composed of four horizontal cylinders, two large and two small. The circulating pumps, worked by small special engines, may be arranged for pumping out water in case of a leak. A special engine also works the steam capstan. There are twelve boilers with four furnaces each. On the trial trips in the early part of 1878, the "Tourville" realised a speed of 16·9 knots. She is reported to have proved herself handy both under steam and under sail, tacking and wearing with certainty and promptitude. Her qualities as a sea-boat were also found to be satisfactory, and she could keep a good wind even in heavy weather. It was observed, however, that under such circumstances she did better—as might have been expected—under easy steam, and fore and aft sails. She carries 800 tons of coal.

Somewhat smaller, but closely resembling the last ship in design, is the "Duquesne," whose trials have only lately been finished. She was laid down in 1873 at a Government dockyard. The hull, which weighs 2,700 tons, is of steel with iron plating; it is covered with two thicknesses of wood, and coppered. The following table of dimensions shows where and how much she differs from the "Tourville."

Length at the water-line	326 feet
Breadth..	50 „
Draught of water (mean)	22 ft. 6 in.
Displacement, tons	5,436.

The number and calibre of the guns carried are the same; and they are mounted in the same way in both ships. Like the "Tourville" the "Duquesne" is a full-rigged ship. The engines are on the compound system, and have six horizontal cylinders, three large and three small. The "Duquesne" was expected to prove as powerful and fast a ship, and as good a sea-boat as the one last described. She carries a smaller supply of coal, viz., 660 tons.

The "Duguay-Trouin" belongs to the larger description of cruisers of the second class. She was begun in 1873 from plans by M. Eynaud, Naval Constructor. Her principal dimensions are given below:—

Length at the water-line	270 feet.
Breadth	43 ,,
Draught of water (mean)	16 ft. 10 in.
Displacement, tons	3,117.

The hull is built in the same manner as that of the two last ships, and weighs 1,600 tons. The armament is upon the upper deck, and is comprised of eleven guns, five of 7½-inch (19 c.m.), and five of 5½-inch (14 c.m.) calibre, of these one is a revolving gun right forward, one right aft, and the remainder are on the broadside; two being mounted on projecting sponsons on each side. The vessel is bark-rigged. The engines, also made at the Government steam factory at Indret, are on the compound system with six cylinders. There are eight boilers with 34 furnaces, and a grate surface of 497 square feet. The indicated horse-power looked for is 3,740, and the speed 16 knots. The ship's coal supply is 430 tons.

Of smaller size, but belonging to the same class of second class cruizers, are the "Villars," "Forfait," "Magon," and "Roland." The first-named was begun in 1875, and was designed by M. Sabattier. The hull is of wood, the weight being 1,000 tons. The principal dimensions are:—

Length at the water-line	250 feet.
Breadth	38 ft. 9 in.
Draught of water (mean)	16 feet.
Displacement, tons	2,268.

She is officially stated to carry six 6½-inch (16 c.m.) guns, and nine 5½-inch (14 c.m); one of the latter being under the topgallant forecastle, and one on the stern gratings. The contour of the "Villars's" bow is somewhat swan-breasted like that of the "Danäe" class in the British Navy. She has three masts with yards on each. The engines are to indicate 2,500 horse-power, and the speed is to be 15·5 knots; 400 tons of coal are carried.

The "Lapérouse," "d'Estaing," "Monge," and "Nielly," designed by M. Bienaymé differ somewhat in dimensions from the foregoing. The "Lapérouse" was begun in 1875, and has the following dimensions:—

Length at the water-line	263 feet.
Breadth	37 ft. 4 in.
Draught of water (mean)	17 feet.
Displacement, tons	2,236.

The armament, rig, engine power, and speed are the same as those of the "Villars" class. None can raise the screws, which are four-bladed.

The "Eclaireur," and "Rigault de Genouilly," designed by the same Constructor as the "Lapérouse," are types of the 3rd class cruiser. The former of these two was laid down in 1874; their hull is of wood and weighs 790 tons. Her principal dimensions are:—

Length at the water-line	236 feet.
Breadth	35 ft. 6 in.
Draught of water (mean)	14 ft. 9 in.
Displacement, tons	1,643.

This vessel is rigged as a three-masted schooner, has one four-bladed screw, and a rudder which is well below the water. She carries eight 5½-inch (14 c.m.) guns, of these six are mounted on the broadside and have an extensive arc of fire over the low bulwarks; one is on the top-gallant forecastle, and one on the stern gratings. The towing torpedo is stowed on tumblers, sheet-anchor fashion, just above the water-line abaft a line drawn from the after end of the main chains. The tow-line is led forward and brought in on the top-gallant forecastle, to break-winches which are placed there to work it and which are not under cover.

The "Chasseur" represents the class of *avisos*, or despatch vessels, to which belong also the "Bisson," "Labourdonnais," "Voltigeur," "Lancier," and "Hussard." The "Chasseur" was designed by M. Sabattier and was laid down in 1873. Her principal dimensions are given below:—

Length at the water-line	199 ft. 6 in.
Beam	28 „ 6 „
Mean draught of water	11 „
Displacement, tons	794.

The hull is of wood. The vessel has a long snout forward; and is rigged as a three-masted schooner with yards on both fore and main masts. The shrouds of the fore and main-rigging are set up to channels outside in the usual fashion. The bulwarks from the after end of the fore chains to a point abreast of the funnel, and also on either side of the quarter-deck, are removed and replaced by stanchions and a wire-netting, in which hammocks could be stowed, and which can be easily cleared away when preparing for action. The position of the boats seems carefully arranged to keep them clear of the fire of the guns. Of the latter there are four of 5½-inch (14 c.m.) calibre, all mounted on slides amidships, viz., one on the top-gallant forecastle, one abaft the foremast, one on the quarterdeck, and one on the stern-grating. The engines, built at Indret, indicated a power of 700 horses. At the trial of the "Bisson," a sister-ship of the vessel described, the indicated horse-power was 849, and the measured speed somewhat more than 12 knots. The amount of fuel that can be stowed is 110 tons.

The "Crocodile" is a first class gunboat, or perhaps more correctly

gun-*vessel* if we have regard to the distinction between the two designations in force in our own Service. Like so many other vessels, large and small, which have been recently added to the French Navy, she was begun in 1873. She is built on the composite system and has the following dimensions:—

Length at the water-line	141 ft. 8 in.
Beam	24 „
Draught of water (mean)	8 „ 3 in.
Displacement, tons	460

The armament originally proposed for this vessel—which has apparently been lately changed—was one 7½-inch (19 c.m.) gun, mounted on a slide amidships; and two light 4-inch (10 c.m.) guns, one forward and the other abaft. The vessel has three masts. The engines were made at the works of Claparéde and Co. at St. Denis, and have two cylinders on the Woolf system. The boilers are cylindrical and have four furnaces. On the trial trip the horse-power indicated was 457, and the speed attained 9·7 knots. The "Crocodile" can stow 50 tons of fuel.

The "Allier" and four sister ships are designated *transport-avisos*, an appellation which may perhaps be rendered into the language of our navy, "armed store-ships." The first-named was laid down in 1875. The principal dimensions of the hull, which is composed of wood, are:—

Length at the water-line	209 feet.
Beam	34 ft. 6 in.
Draught of water (mean)	14 ft. 9 in.
Displacement, tons	1,597.

She carries four 5½-in. (14 c.m.) guns amidships, which are traversed on circular racers with slides pivoted in the centre. She can carry 220 tons of stores, and 180 tons of coal. Her rig is that of a full-rigged bark. The nominal horse-power of the engines, which have three horizontal cylinders, is 150.

The "Annamite" is one of six large troop-ships, which may also be employed as hospital ships; and are probably intended to perform the same kind of service between France and the new colony of Cochin-China, as is performed by the Indian troop-ships of the British Service. With the exception of the one named, iron and steel have been used in the construction of the hulls; she, however, is built on the composite system, with wood planking. She has three square rigged masts. These are her dimensions:—

Length at the water-line	344 ft. 6 in.
Beam	50 „ 3 „
Draught of water (mean)	21 „ 8 „
Displacement, tons	5,429.

The engines were manufactured at the Creuzot Works, and indicated 2,479 horse-power, which gave a speed of over 13 knots. The supply of fuel which can be carried in the bunkers is 700 tons. The "Annamite" has accommodation for 792 passengers in all. There is room

for the beds of 136 sick in the regular hospital, and this number of beds can be increased if necessary, by the addition of 112 in the part of the vessel intended for ordinary passengers or troops.

In the newer vessels specially intended for coast defence, it is notable that the French Government have adopted the principle of the revolving turret, and that they have used it in combination with the breastwork, or elevated armoured redoubt in the midship part of the vessel, with which our Service has been familiar since the completion of the "Cerberus" and "Cyclops" class. In France, however, only a single turret, with a pair of guns in it, has been placed in these vessels, of which there are two classes, both unmasted. The "Tonnerre," "Furieux," and "Fulminant," designed by M. de Bussy, belong to the first. A description of the "Tonnerre" will suffice for all. The hull is composed of iron and steel; the weight of the armour is 2,070 tons. The thickness of the latter on the turret is $13\frac{3}{4}$ inches; on the side, at the water-line, 13 inches; and on the armoured deck, 2 inches. The principal dimensions are the following:—

Length at the water-line	248 feet.
Beam	57 ft. 9 in.
Draught of water (mean)	20 ft. 8 in.
Displacement, tons	5,580.

In their general features the designs, both of this class and of the smaller, are much alike. The revolving turret is placed at the foremost end of what seems a somewhat over-long breastwork. Above it rises a superstructure which supports a hurricane deck of exceptional elevation. Round the edges of this deck are hammock nettings, and at the corners, light guns are mounted. A limited amount of accommodation for the crew is provided by a continuation, in thin iron plating, of the armoured breast-work. The lower edge of the water-line armour-plates is brought well down over the point of the ram. The boats can be stowed on the nettings of the hurricane deck. There is a curious detached topgallant forecastle of triangular shape near the bows, which probably contains the "heads" for the ship's company. A central crane is fitted forward to perform the double duty of catting and fishing the anchor. The armament of the turret consists of two $10\frac{1}{2}$-inch (27 c.m.) guns; but arrangements have been made by which these can be replaced by $12\frac{1}{2}$-inch (32 c.m.) pieces if desired. The "Tonnerre" is supplied with the proper fittings for working the towing torpedo. For her engines the old machinery of the iron-clad "Normandie" have been used, certain improvements having been made in them. There are eight boilers; with an indicated horse-power of 4,166, a speed of upwards of 14 knots was reached; at 12 knots the circle was completed in 3 minutes 48 seconds. The vessel can stow 290 tons of fuel; she is propelled by one screw, and has a perfectly flat bottom with a very clean run aft.

The second class coast defence turret-vessels, three in number, of which the "Tempête," was begun in 1872, differ only in dimensions from the preceding, as will be seen from the figures which follow:—

Length at the water-line	241 ft. 6 in.
Beam..	57 „ 9 „
Draught of water (mean)	16 „ 8 „
Displacement, tons	4,524.

The thickness of armour on the sides and on the turret is $11\frac{3}{4}$ inches. The armoured deck has 2-inch plating. The two guns in the turret are of $10\frac{1}{2}$-inch (27 c.m.) calibre. The "Tempête" has a single screw, and the engines, made at the Indret factory of the Government, are on the Woolf system, with six cylinders; the large and small being coupled and working the same cranks. The indicated horse-power is 1,500, and speed at the mean draught of water given above, 10 knots.

The foregoing account of the new classes of vessels, which the Government of France has added to the Navy within the last five or six years, will convey a fair idea of the extent to which the reconstruction of the floating *matériel* is being carried. The fact that the sum of money originally contemplated, as being required to replace the older vessels with those of improved design, has been found insufficient for the purpose, is in itself a proof of the determination of the French Naval authorities to avail themselves during the reconstruction of such improvements as may from time to time be suggested; and of this there is other evidence to be found in published documents. It is true that very severe strictures have been passed upon several of the types of ship recently built, and a certain amount of discontent with the performances of such as have been tried has been manifested. But the Minister of Marine and his colleagues have defended their construction, and have repeatedly stated that they desire the fullest investigation into the qualities of those which are sufficiently advanced for satisfactory trials of them to be made.

PARLIAMENTARY DISCUSSION OF THE FRENCH NAVY ESTIMATES.

In the last number of the *Revue Maritime*, there is a lengthy article upon the Estimates for the French Navy for the current year; and the debates which took place on their introduction in the Chamber of Deputies. Though far too long for complete reproduction here, it contains so much likely to prove interesting to English Naval Officers, that an abridged translation of the more important parts of the article, and of the speeches reported, are given below.

Hitherto the Estimates presented to the Chamber were divided into two parts, those for the Naval, and those for the Colonial Service. Since 1874, a sum of money was yearly voted for certain special purposes, particularly for the reconstruction of the *matériel* of the fleet. It is now intended that such money shall be added to the charges of the department as a 3rd part, or section of the Estimates,

under the name of "Extraordinary Expenditure." The Estimates for the financial year 1879 amount to a total of 217,407,369 francs (£8,670,000), thus divided.

1st section.	Naval service	165,748,862 francs	(£6,630,000).
2nd section.	Colonial service ..	30,467,623 francs	(£1,210,000).
3rd section.	Extraordinary expenses	21,190,884 francs	(£840,000).

The Estimates for the preceding year nominally exceeded the total of the present by rather more than £150,000. This difference, however, is only apparent, the actual Estimated Expenditure for 1879 being greater than that for 1878; and there being an increase in many, if not in nearly all of the votes for the Naval Service. The first important addition met with, is to Vote 4, for the maintenance of the *personnel*, both afloat and ashore. Here the increase is nearly £32,000; and the following explanation is offered:—

"The composition of the fleet will, in 1879, undergo certain "alterations. The number of ships in commission will be diminished "by two, from 120 to 118. The annexed table shows, for each of the "two years, their distribution amongst the several Naval Stations.

	No. of Ships in 1879.	No. of Ships in 1878.
Evolutionary Squadron	12	12
Algeria	3	3
The Levant	3	3
West Indies	4	4
Newfoundland	3	3
Martinique	1	1
Guadaloupe	1	1
Guiana (French)	4	4
Iceland	2	2
South Atlantic	8	8
Senegal	4	4
Pacific..	4	4
Tahiti..	2	1
China and Japan	4	5
Cochin-China..	6	7
New Caledonia and Transport	8	8
Réunion and Comoro Islands	3	3
Protection of fisheries	6	6
Coast survey	1	1
Particular service	11	12
Harbour stations	7	7
Ships being tried	9	8
Reserve ships for contingencies	6	7
	112	114
Cruizing training ships	6	6
	118	120

"The China squadron was composed, as appears above, of 5 vessels "in 1878; it will consist of 4 in 1879. The despatch gun-vessel "which belonged to it has been reduced, as she could not contend, "without serious danger, against the heavy sea and high winds of

"that part of the world. The same reason has led to the sub-
"stitution in the Cochin-China command of a 3rd class cruiser for
"the gun-vessel, and the gunboat. The squadron, consequently, will
"lose one vessel without its importance being diminished. For par-
"ticular service, and in readiness to take the place of others, 2 ships
"have been reduced; but, on the other hand, provision has been made
"for one ship under trial more than in 1878; and a second schooner
"has been added, at the request of the Commander-in-Chief of the
"Pacific Station, to the Tahiti squadron, not only to render our
"superintendence secure, and to cause our Protectorate of the
"Society and Marquisas Archipelago to be respected, but also to
"prevent our establishments there being deprived of support, in case
"of accident, which is always to be feared in waters of which the
"navigation is so difficult.

"These, as far as regards number of ships, are the changes made in
"the fleet in 1879. The result of them would have been a reduction
"in the expense due to the maintenance of our naval force, if another
"cause had not intervened to influence our arrangements in the con-
"trary direction. This relates to the re-arrangement which had been
"brought about in certain squadrons and stations, with a view to
"replace ships found unsuitable by others of greater efficiency, or to
"substitute for vessels of the old type those of the new which, on
"account of their great size, require a larger ship's company. Thus
"in the Mediterranean Squadron, an armoured vessel of the
"'Valeureuse' class has taken the place of one of the 'Marengo'
"class, a cruiser of the "Desaix" class that of one of the 'Chateau
"'Renaud' class. And, besides, a cruiser of the 'Forbin' type has
"been attached to the squadron instead of a despatch vessel. In the
"Levant the gunboat has been replaced by a despatch vessel. With
"regard to particular service two transports of the 'Sarthe' type
"have been replaced by two of greater tonnage like the 'Annamite.'
"From these various changes it results that, in spite of the diminution
"of the number of ships in commission, the effective of the crews
"afloat is increased by 591 men, and the expenditure of vote 4
"under this head, by £18,400."

Amongst the several causes of the increase of the vote are found provision for a greater number of Flag Officers; for additional pay of Assistant Paymasters and Surgeons after 12 years' service; increase of the pay of Ships' Stewards and Storekeepers, and of first and second class Petty Officer Engineers; additional table-money for Officers of certain ranks and Warrant Officers; "the increase in the table money
"of the junior Officers has been demanded for a long time. The
"present sums allowed are those which are to be found in the Decree
"of the 11th Prairial, year XI; and which have been repeated in the
"Ordinance of May 15th, 1834, and all subsequent regulations.

"It should be stated that the division of the table, or mess allow-
"ance, into three categories, according to the stations of the ships,
"does not answer the requirements of the present day. It is in
"fact certain that in the ports in which the allowance under column
"2 is granted, especially in England, North America, and New York,

"living is as dear as, if not dearer than, in a large number of places "giving a right to the allowance under column 3. It seems there- "fore sufficient to divide the table-money into two categories, one for "ships stationed on the coasts of France and Algeria, and the other "for those cruizing elsewhere. The table which follows shows the "augmentation proposed:—

"JUNIOR OFFICERS' MESS.

	Present Daily Allowance.			Proposed Daily Allowance.		Increase per diem.
	s.	*d.*		*s.*	*d.*	*d.*
Column 1 ..	1	10½	Column 1 ..	2	6	7½
„ 2 ..	2	6	} „ 2 ..	3	4	6¼
„ 3 ..	2	9¾				

"WARRANT OFFICERS' MESS.

Column 1 ..	0	5	Column 1 ..	0	7⅓	2⅓
„ 2 ..	0	6½	} „ 2 ..	0	10	2½
„ 3 ..	0	7½				

Passing to votes 9, 10, and 11 of the first section. and 1 and 2 of the third section of the Estimates, we find the bulk of the sums devoted to the *Matériel* of the Navy. In these votes are comprised the credits which have usually been included in the ordinary estimates and those which were formerly placed under the heading of "*compte* "*de liquidation*," but which from the present year forwards will be included in the annual accounts under the third section. "The principal "object of these votes," we learn, "is the reconstruction of the naval "*matériel*." The total sum demanded for 1879 is 92,692,134 francs, or more than £3,700,000.

The arming of the ships of the French Navy, unlike that of the British Service, is under the charge of a department of the Naval Service, and the sums required for it are included in the Navy Estimates. "The expenditure comprises what is necessary for the "supply of the gun-factories at the ports and a portion of the "purchases to be made for the manufacture of eight steel guns of "16½-inch calibre or 72 tons weight, six 50-ton 13½-inch guns of steel, "two 10½-inch steel, and fifty 5½-inch cast iron guns, with interior "tubes and external hoops, as well as the carriages and ammunition "required for this new ordnance. In addition, a considerable sum is "wanted for tools and machinery for the shops in which heavy guns "of 72 or 100 tons' weight may be made."

These points have been noted, as being those most likely to interest English Naval Officers who are in the habit of comparing the condition of our own Service with that of foreign Navies. And it seems good to follow them up with extracts from the discussion of the

Estimates in the Chamber of Deputies. It may be observed that it is the rule in the French Legislature to submit the Estimates first of all to a Select Committee, who depute one of their number to draw up a report on them; and it is on the presentation of this report, usually a document of great copiousness going very fully into every detail of the proposed expenditure, that the main discussion, or debate, takes place. This, on the present occasion, was begun by Admiral Pothuau, the Minister of Marine, who amongst other things is reported to have said:—

"The programme of 1872 is not immutable as far as concerns "the types which compose it. For example, the 1st rate armour-"clad ship of 1872 is not the 1st rate of the present day. In "1872 we were satisfied with giving her armour of 12 inches' "thickness: the last vessels laid down have a thickness of 22 "inches. At present the 1st rate armour-clad mounts guns of "48 tons and guns of 74 tons are being made, whilst those of 100 "tons are becoming indispensable. Must it then be said that "every ship whose armour has not a thickness of 22 inches and whose "guns are of a less weight than 100 tons, must be removed from her "class and considered unfit to comply with the conditions of the "programme of 1872? If it were so we might confess that that "programme would never be realised, and that it would prove the "same in every other country. When I laid down the bases of the "programme of 1872, I never expected that it would be thus inter-"preted. What is indispensable in order that the Navy may fulfil "its engagements is, that in 1885, it may possess, in a perfect con-"dition for service, the number of ships fixed for each class, and that "ships from time to time removed from the list since the drawing up "of the programme, because of age, should be replaced by a proper "number of others which should come up to the ideas and require-"ments of the time when they were put upon the stocks. In "England and in Italy this is the rule, and if the latter Power is to "be in possession in 1887 of 16 1st rate armour-clads, it is scarcely to "be doubted that they will not all be as powerful as the 'Duilio' and, "still less, as powerful as the 'Italia.'

"For many years the fleets of England and of all the other mari-"time Powers count in their lists ships with armour of 4, 6, and "7 inches' thickness, like the 'Warrior,' the 'Black Prince,' the "'Defence,' the 'Friedrich-Carl,' the 'Castel-fidardo,' the 'Venezia,' "&c. In 1885 the French fleet will only possess, of 16 1st rate "armoured ships, 3 with armour 6 inches thick, against 13 with "plating of 8, 14, 15, and 22 inches thick. Including the coast-"defence vessels of the 'Caïman' class we shall have 7 armoured "vessels with 22-inch plating . . . . Starting with the idea "that all the ships of 1885 should be of the latest and most perfect "design, the author of the report of the Select Committee says, that to "complete our programme of 1872, it would be necessary to lay "down and finish before the above date the following additional "vessels:—

"3 1st rate sea-going armour-clads.

" 2 2nd rate sea-going armour-clads.
" 3 1st „ Coast defence vessels.
" 3 2nd „ „
" 3 despatch-vessels.
" 26 1st class gun-vessels.
" 5 large transports.
" 1 small „

" He adds that even after these 49 vessels are ready for service, the " programme of 1872 will not have been completely carried out, " because the cruisers will not all be of the most powerfully armed " and rapid type. . . . . I conclude, on the contrary, that to " satisfy the conditions of the programme 31 vessels will suffice: " viz:—

" 3 2nd rate armour-clads.
" 3 Coast defence vessels of the 'Tonnerre' class.
" 1 2nd rate coast defence vessels.
" 20 gun-vessels.
" 4 large transports.

" We are not behindhand with the programme, and our building " power permits us not only to maintain the effective of the promised " fleet, but also to keep pace with the progress of naval architecture " by laying down, at the proper time, ships intended to replace those " which shall disappear in the years following 1885. . . . . At " this moment a building yard at Bordeaux has undertaken the con- " struction of a large transport and that of a coast defence vessel of " the 'Caïman' class, which may truly be called a thorough 1st rate " armour-clad, since a displacement of 7,200 tons is provided for the " vessel, which will carry 74-ton guns, whose armour will be 22 " inches thick, and whose trial trip ought to result in a speed of 14·5 " knots. . . . In the matter of naval ordnance we have a " programme as we have for ship-building; and it is modified just as " the types of ships change. In our factories guns of 48 tons are " just being completed, and the factories have been supplied with the " proper plant for that purpose. Private firms are turning out the " main portion, the tubes, and external hoops of 8 guns of 74 " tons; but I do not believe they are in a position to put them " together, and still less those of 100 tons. We must, however " consider more than ever how to procure the latter for the arma- " ment of our largest ships already on the stocks; and it is on that " account that I have asked for the votes necessary for the creation of " workshops in which the manufacture of guns of great calibre may " be completed."

The author of the report of the Committee, M. Lamy, rose to defend that document, and where necessary, to reply to the Minister. He justified the proceedings of the Committee, saying, " Our object " has been to develop the Naval strength of France. The first " obstacle to this development is, that of the resources of the " Ministry of Marine the *personnel* takes a greater and greater share, " whilst the *matériel* receives one which is more and more reduced. .

" . . . The second obstacle is the manner in which the votes are " distributed between new constructions, the expenditure on the " active fleet, and the general service. By a continuous progression " the last two increase and usurp a portion of what is devoted to the " first. We have asked that in the disbursements for general " service and the expenditure on the fleet, a reduction of 6 millions " (£240,000) should be made, and that this sum should be added to " the vote for new constructions. To this the Minister has consented. " Finally we have examined the condition of the stores which ought to " suffice for fitting out and building ships. . . . . England, which " spends from 55 to 65 millions (£2,200,000 to £2,600,000), has in " her Magazines 85 millions' worth (£3,400,000) of stores in general. " France has 246 millions (£9,840,000). This stock has seemed to " us excessive. . . . . Thus the present estimates are dis- " tinguished by three measures; by the first, the proper proportion of " the *personnel* is attempted to be secured; by the second, activity in " building; and by the third, order in the Magazines."

The last speaker was followed by M. Eugène Farcy, whose criticisms of the Ministerial measures are worthy of notice. "There is " one thing," he said, "upon which we are all agreed; and that is, that " if the Navy is in want of millions, of many millions, to perfect its " organization, we will accord them to it without discussion, but just " because we consent to give them, we ought for that very reason to " insist with scrupulous care in seeing what use they are put to. The " question is to know if these millions are employed for the good of " the country, or if—as the lamented M. Thiers used to say—we ex- " pend them for the good of our naval architects and that we may " launch out into costly trials from which other nations only derive " benefit. . . . Permit me to say a word or two on the re- " markable report of M. Lamy. For the first time we have a Com- " mittee examining the estimates in a spirit opposed to the Ministry. " This report has thrown much light upon certain faults of our system " of accounts; it has shown that there takes place in the Navy a " squandering, not only of the *personnel*, but even more of the *matériel*. " . . . . It is truly an honour for M. Lamy to have brought " these facts to light, and as no man is a prophet in his own country, " no more in the Navy than elsewhere, and, as perhaps as a sailor I " should not have been listened to, I am glad, for my part, to see a " man, who does not belong to the service and who cannot be accused " of party spirit, render to the Navy the service of telling it the " truth. . . . . First there is the question of the *personnel*. " . . . . I do not think it wise to reduce it. I am speaking of " the officers of the Executive branch. At any moment we may " require them, and they may not be easily found if we diminish the " lists. You cannot build Officers as you do Ships. The latter are " formed with millions of money, the former by much study and sea- " service. The *personnel* which has been reduced might have been " employed either in the Coast defence (? Coast Guard), or in com- " manding the Naval Reserve. . . . But having reduced the lists " of Officers by a fifth, the result is a very extraordinary thing. At

"the same time that the lists are reduced one-fifth—I speak of "Executive Officers—juniors and seniors, the list of Flag Officers is "increased by one-half. Before the war there were 31 Admirals, "whilst now, with diminished lists, we have 41; that is to say, at "this moment we have more Admirals than there are armoured ships "for them to command. . . . . If you wish to economise in the "*personnel*, it is easy to reduce the effective of the crews. But in the "Navy there is a bad habit of continually increasing ships' comple- "ments. If you examine a complement list, you will see that that of "every ship is being continually increased by 3, 5, 10, 15, 20 men. ". . . . Formerly when French sailors were accustomed to board "the enemy . . . I can understand that it was necessary to put "plenty of men on board ship; because the more men that could be "ordered to attack, the more chance there was of success. But now "the conditions are completely altered. Ships engage by boarding "no longer; on the contrary, it is sought to avoid that kind of fight- "ing. We have at present ships the ram of which could pierce an "enemy's vessel with a single blow and sink her almost immediately. "Now, at a time when one is almost certain that a ship can be sunk "in that way, it is simply a question of prudence and humanity to "put on board as few people as possible, only those absolutely neces- "sary for the duties of the ship. You know that with a simple little "boat provided with a wooden spar, at the end of which there is a "torpedo of 50 lbs, you can sink in a few minutes—as was done in "the Russo-Turkish war—armour-clad ships. It would then, I "repeat, have been both prudent and humane to reduce the numbers "of your crews. In England this has been prudently understood. "If you compare the complements of French ships with those of "English, you will see that the largest armour-clad of the English "Navy, with a displacement of from 10,000 to 11,000 tons, has only "390 men; whilst in France, the 'Marengo,' a ship of about 8,000 "tons, has 702 men. . . . . Not only is it so in the heavy "armour-clads; we find the same thing in the smallest craft. Thus "you will see in an official report that in a gun-vessel we have 77 "men, whilst in the 'Coquette,' an English vessel of the same size, "there are only 58."

The speaker then proceeded to discuss certain discrepancies in the accounts; and the sums demanded for the purchase and supply of certain stores. He afterwards went into the question of building in Government and private yards. Speaking of the number of "days' "work" in particular ships, he said, "that it was altogether excessive." Thus to cite "only one example—the largest ship in the French Navy, "the 'Amiral Duperré,' built by a private firm, counts 411,000 days' "work, and has 10,487 tons' displacement. If we compare with her "a ship built in the dockyards and being of only 8,000 and odd tons, "we see that the number of days estimated for in the return is at first "800,000: 800,000 against 411,000. But the singular part of it is that, "in allowing for nearly double, we were yet in error. This figure of "800,000 is not exact, for when the Committee asked the number, it "was told, 900,000. And when it was known I had asked for the

"return, the Committee was informed that the figure exceeded a "million. So that for a class 2,000 tons smaller than the 'Amiral "'Duperré,' a million days' work are required; whilst for her only "411,000 suffice. . . . . The reporter of the Committee has been "informed that as a rule in the Navy they are in error by about a "third; and that, when a certain number of days is stated, one-third "must be added to it. . . . .

"Private firms, when we have recourse to them, are compelled, "under pain of enormous losses, to keep to the number of days' work "estimated for and to the price calculated: whilst in the Government "dockyards they are continually in error, and in this manner we see "the cost of ships is enormously increased. There is one chief reason "for this, and that is the small amount of work done by the dockyard "workmen." After alluding to official documents dating back as far as 1850, the speaker next cited "a report which had just been "addressed to a Select Naval Committee by the Maritime Prefect of "Lorient. The construction of the 'Devastation' was under con-"sideration. The Prefect first stated 'that too many days' work were "'expended upon ships out of commission. The second cause which "'has prevented the construction of the "Devastation" being as rapid "'as it would have been in a private establishment, is the insufficiency "'in number and quality of the draughtsmen.' A much more serious "matter is also stated in the report of the Prefect:—It is said that "the 'Redoubtable' will have required two years' work, after having "been launched. The report also alleges that if such a large amount "of work has been expended upon this ship, it is on account of faults "in her armour-plating, faults only corrected by a great deal of "cutting away. . . . They have been obliged to cut away and "reduce iron plates of 14 inches, and it unfortunately happens that "when the work is finished, the thickness of the armour is less than "had been considered necessary. . . . It will be sufficient to "indicate certain results of all this; for example, the 'Redoubtable,' "which ought to have cost about £284,000, has now risen to £370,000 "for the hull alone, without counting engines, guns, and stores. ". . . . A further proof of the great difference in cost of ships "built in the dockyards and those built by private firms is, that if the "cost be divided by the number of tons, it is stated that for the "largest ships in the Navy, like the 'Amiral Duperré,' the cost is "£21 10*s.* per ton, whilst for the 'Redoubtable' it amounts to £26 10*s.* "That is to say, the difference per ton is £4, and is against the dock-"yard work." M. Farcy proceeded to address himself to the qualities of some of the new classes of ships added within recent years to the French Navy. This portion of his speech will probably interest English Naval Officers even more than those parts of it in which the expenditure is criticised.

Taking the "last class which has just been completed, the 'Tonnerre,' "on which has been spent a sum of something between £40,000 and "£60,000 more than was intended;" the speaker affirmed that she "had attained the speed required, but only by impairing her other "sea-going qualities; she is said to have no stability. This vessel,

"on the open sea, in bad weather, worked so irregularly that she had "to return to her anchorage. The form of the hull is different from "that of other vessels; she has been given the shape of a barge, "with a bow and stern like those of ordinary ships. This barge shape "not only gives no stability, but it is also bad for manœuvring; the "particles of water divided by the bow are hardly able to re-unite "astern to supply a fulcrum to the screw and rudder. For this "reason vessels of the class are provided with rudders of such huge "dimensions that they require a steam engine to work them; manœuv-"ring is thus rendered more difficult. Besides, when it is wished to "perform certain rapid movements, like altering course, the ship has a "heel varying from 16° to 22°. I ask what would be the fate of a ship "which, in action, having to manœuvre, should heel over 22°, "completely exposing her crew, not only to the musketry fire, but to "the gun fire of the enemy. I say that the heel was only 22°, but I "might add that during the trial trip the order was given to put the "helm amidships for fear the vessel might capsize. I do not say that "things went quite so far as this, but, at all events, it has been stated, "that the trials were not carried to the end for fear of accidents, the "gravity of which could not be foreseen. To show that she has not "the qualities which might be expected from a vessel on which "£320,000 have been expended, it is sufficient to say that in one of "her last trips, when the ship was attached to the evolutionary "Channel Squadron, to go from Cherbourg to Brest, the weather "having become rather bad, the squadron continued its course to "Brest, but the 'Tonnerre' had to return to the anchorage in "Morlaix Roads. When the weather improved she rejoined "the squadron, but had to be convoyed by the despatch-vessel "'Souffleur.'

"From the large ships, I go on to the small ones. We have turned "out vessels of the cruiser classes, to which it has been desired to give "speed, but, I repeat, by diminishing their sea-going qualities. "Taking the 'Sané' and 'Infernet,' I find these sea-going defects. "The two were sent to sea in company, to carry out experiments with "regard to both their sea-going qualities and their engines. The Com-"mittee which was appointed to conduct them has drawn up a report, "in which, whilst maintaining those extraordinary considerations "which so often tend to the acceptance of inferior articles, it is "compelled to admit that these two ships do not at all come up to "the object with which they were built. Both have a very fair speed "under steam, 15½ knots, at the trial; but the 'Sané' would not "remain on an even keel, and it is necessary to put on an extra "sheathing if we wish to make use of her. As for the 'Infernet,' less "unsuccessful, she can keep the sea; however, she is not a sure ship, "and the Committee recommends that she should avoid high speed "with a beam or quarter sea, which might occasion some danger. So "much for our second-class cruisers. In addition to this, in the Navy "it is no secret that the officers are very dissatisfied with this class, "which are not steady, and which roll so heavily as to wear out their "ship's company.

"If I go on to the small craft, the results are perhaps still worse. "Two or three years ago, there was a desire to build new classes of "gunboats capable of making long voyages, to China or Cochin-"China. I do not know how far one is justified in saying that we "have built gunboats rather than despatch-vessels, seeing that the "report of the Committee on the trials of them states that they are "not doing what they were intended to do, because they are made to "carry out ordinary duties which are not their proper ones. Thus it is "said: these gunboats have to fire on coasts, in calm weather, and "we must not expect of them that which they cannot perform. ". . . . We wish to make gunboats which go long voyages; "when at sea, their performances being bad, we are told that they "are only gunboats, and that we must not expect from them per-"formances for which they are not fitted. One of the first built is "the 'Lutin.' . . . . An early passage in the report [on her "class], expatiates on the inconvenience of putting so large a number "of men on board these craft. The ship's company is said to amount "to 77 men, whilst there are only 42 hammocks in the ship, so that "at sea the men have to chum (*amateloter*). I will explain to "honourable members who do not know it, what this word means. "When a ship has not room enough to berth her men, two men have "a hammock between them. They do not sleep together, but both "use a single hammock; when one goes on deck to keep his watch, "his relief takes his place in the hammock. This is what they have "to do in these gunboats. . . . . They cannot carry a sheet-"anchor, which is a serious inconvenience. . . . . The 19 c. m. "(7½-inch) gun mounted in this small craft had to be carried amid-"ships between the engine-room hatchway and the mainmast. As "gunboats usually fire ahead, it may be seen that these have an "armament which they cannot make use of forward. This is an "extreme disadvantage to these vessels, which only avoid an enemy's "shot by presenting their smallest area to him. There is another "which is very serious at sea; the gun, which is too heavy for these "vessels, is kept secured in line with the keel, for fear of causing "serious damage, by enormous stays fastened by iron wedges, which "have to be driven in with a maul, so as to prevent the slightest play. "You perceive of what use a gunboat can be, which has to make her "armament immovable so that it cannot be worked. On this account "the Committee, whilst remarking that her duties must be somewhat "circumscribed at sea, observes: the gunboats are intended to fire in "particular places, near coasts, in rivers, &c. . . . . If this "class had succeeded, I should not complain that they had cost "£22,000 to build. But in spending that sum, it was intended to "give them much greater speed by putting in them more powerful "engines; it was also desired to give them length and breadth, so as "to increase their displacement without adding to the draught of "water.

"The effect has been quite the contrary. The 'Lutin,' for example, "draws nearly a foot more than the other vessels, like the 'Actif,' "which cost only £12,000 and odd, and draws 3 feet more than the

" 'Chacal'; and the 'Actif' goes one knot faster. You perceive that " the object has been to get less draught of water, and greater speed, " and we have a larger draught, and one knot less speed. This is not, " even yet, the worst result obtained. The Committee reports:—

"The 'Lutin' has impressed the Committee more favourably than the " 'Crocodile.' Perhaps this is because the 'Lutin' Committee has " admitted that the service on which that vessel may be expected to be " employed is limited, and that the word *gunboat* means a craft whose " sphere of action cannot be very extended, and which can only be " called upon for service in time of war on coasts and rivers. The " Committee concludes: As to sea-going qualities the conclusion after " the 'Crocodile's' trials is as unfavourable as possible; as regards the " 'Lutin' it has been a little less so. The 'Crocodile' is at present " employed in the service of the pilots of the 1st *arrondissement;* her " Captain has no higher opinion of her than the Committee.

"It is to be observed, however, that this temporary duty obliges her " to go to sea in all weathers, for which she was not intended, being a " gunboat. Here then is a ship intended for duty as a gunboat: as " it could not carry its heavy gun, a lighter one was put in its place, " and the vessel employed on different duty; it being said of her, " She does her work badly, but that is not strange as she was intended " for a gunboat. There is another of the same class into which " alterations are to be introduced. This is the 'Lionne,' built by a " private firm, costing also £22,000, on board which, not being able to " mount the 7½-inch gun, weight about 7½ tons, has been placed a 5½- " inch gun, weighing only about 2 tons. Well, after replacing the " 7½-inch by the 5½-inch gun, the Prefect reports to the Minister. " The vessel is being fitted anew for service on the Coast of Ireland;[1] " it is said that the ship is unsuited, in spite of alterations, to en- " counter the heavy sea and high winds of the Irish Coast.[1] You " should be informed that now small dispatch vessels and ordinary " transports, perfectly able to keep the sea, are sent there. The " 'Crocodile' with two 4 c.m. guns in the bows—small land-service " pieces which you may sometimes see passing through the streets— " cannot rise to the waves, and ships heavy seas. It is proposed to " mount only one in the 'Lionne.' There then is a sea-going vessel " which cannot carry two small guns of about 2 cwt. in the bows; one " only can be mounted to prevent the shipping of heavy seas. If " for twice the cost our ships were good and able to render useful " service, I should have nothing to say: but we are told every " minute that our new vessels cannot be employed on the service for " which they were intended."

M. Farcy afterwards touched upon the question of the new naval ordnance. "The Minister has told us," he continued, "that he had " asked for an increased vote for ordnance, in order to make heavy guns " 100 tons. I believe nearly all the members of the Committee were " of opinion that to manufacture them at once would not be prudent. " . . . . . We are not sure of the efficiency of these guns of " 100 tons; but we are sure that, at this moment, we have no ship

[1] *Sic* in orig. It is probably a misprint for Iceland.

"on which we can mount them. I would speak of the last type, the "'Tonnerre,' which is somewhat smaller than the one on board which "it is intended to place the 100-ton guns. The 'Tonnerre' has sea-"going qualities of so negative a character, she has so little stability, "that if she carried a gun of 100 tons, I do not doubt that when the "helm should be put hard-over, as was done on the trial-trip, she would "be liable to capsize, as fears have already been expressed of serious acci-"dents even with guns of only 30 to 35 tons." The speaker ended his speech by recapitulating the remarks he had made on the subjects of ship-building and expenditure. He added, "There is one thing which I "have not yet said, and that is, that all the vessels we have had built "by private firms have been generally successful . . . . . We "have built the 'Duquesne,' for which we have spent £40,000 more "than the 'Tourville' [built by a private firm]; and the latter goes at "least one knot faster."[1]

On a subsequent day M. Le Belin de Dionne replied to M. Farcy on behalf of the Government. "You have been told in the first place," he said, "that our ships' companies are too numerous, more so than "those of the English service. The 'Lutin' has been given as an "instance, with 77 men, whilst the English 'Coquette' has only "58 or 60; most probably 60 I think. So that I would answer "generally that our small craft, when compared with similar "vessels in the English Navy, have smaller crews. Take the 'Lutin' "in particular; if she has 77 men, she has likewise a displacement "somewhat larger than the 'Coquette'; this shows that she holds an "intermediate place between the 'Coquette' and another English "vessel of the class, the 'Frolic,' which has 80 men. Also our men "are not as strong as the English sailors, and it is on that account "that in general our merchant ships have larger crews than English "vessels of the same tonnage." The speaker then contested M. Farcy's criticisms of the Naval Expenditure, complaining that he had only taken notice of a part of the figures in the accounts, and that an examination of the whole would tend to give different results from those he had indicated. He also cited figures to show that the stocks in store had not been increased. He next adverted to the case of the "Amiral Duperré," and "Redoutable," and stated that the 411,000 days' work accounted for in the building of the former by a private firm were only "figures of account," and not representatives of real artizans' days' work. With regard to the large number of days taken in building the 'Redoutable,' he was able to explain that the experience gained during her construction would enable the "Devastation," 1,000 tons larger, to be built with only 300,000 days' work. As to the difference in price per ton spoken of, he believed M. Farcy had confounded tons displacement with measurement tons; and he averred that the "Tonnerre" had cost less than the "Amiral "Duperré."

As to the report of the unfavourable results of the "Tonnerre" trials, he observed: "If that vessel has caused certain apprehensions

[1] These two vessels are unarmoured cruizers of the 1st class, somewhat smaller than our "Inconstant."

"which find an echo in this House, the same thing happens every time "a new class of ship is introduced into the service, and its merits are "discussed. In the Navy there is a public opinion, and it is seldom "favourable to new designs presented to it for the first time. That is "the case with the 'Tonnerre.' She has, however, in certain respects "surpassed the expectations of the constructors. Not only has she "attained a higher speed than was looked for by nearly a knot, she "has also been found to possess unprecedented turning qualities. "When the ship goes over 14 knots, and turns in a circle of less "diameter than any ship of any navy, she necessarily obeys a natural "law, and heels over. The heel was found to be too great; not "because it endangered the ship, but because it exposed a part which "is not armour-plated. The Minister has therefore ordered some "alterations to be made which will prevent this inclination." After a further defence of the vessel as altered, he proceeded to meet the objections made to the 'Sané' and 'Infernet.' As for them, "and "especially for the 'Sané,' it was the same thing as with the 'Tonnerre'; "and that was, that at a date, now seven or eight years past, this new "class elicited differences of opinion. There have been differences and "their echoes have been heard here; but it should be known that the "Committees which conduct the trials of our ships occasionally dis- "cuss with vivacity the facts which they observe: they draw up "reports which reproduce all the opinions brought to light. The "'Sané' has never ceased to be at sea: not even, so to speak, to be put "out of commission. She is cruising in the West Indies: her sister "ship, the 'Seignelay' has been for three years in the Pacific. We "have cruisers of the same class in all waters. . . . . One, the "'Fabert,' has encountered a cyclone, and has behaved admirably." Of the gunboats, M. Le Belin de Dionne said, "This class has been "borrowed from England; the English have excellent gunboats, and "we have attempted to introduce the class here. We have taken "the 'Coquette' and enlarged her somewhat. . . . . The report "read to you yesterday in the first place is not unfavourable: but "besides the report on the 'Lutin' we have that on the 'Lynx.' The "latter is so favourable that it has been at once determined to extend "this vessel's sphere of service. Since her departure two reports have "been received from her; and her voyage has been considered so "satisfactory, that the Minister has decided to build two others on the "same plan at Rochefort. . . . . We are confident that the vessel "is a good one; and as for the 'Lionne,' in whose construction there "has been a certain miscalculation, which sometimes happens when "work is entrusted to a private firm, the building has given results "which were not expected, and important repairs have to be made in "the hull. In consequence of experiments on a large scale, which we "have had made, and in spite of private estimates of a semi-confiden- "tial character, since we have learnt the good results in the 'Lynx,' "we have no hesitation in sending the 'Lionne' to sea, and if the "strength of the hull proves sufficient, she will proceed to her station "and carry out her duties; as we at the least hope. I admit that "there has been in her case a miscalculation as regards her building;

"we have occasionally encountered similar mistakes when we have "applied to private building yards at Bordeaux or elsewhere. Now "that our apprenticeship is over, and the instruction of our artisans "completed, our work in iron is not only at the least as satisfactory as "those of the *Forges et Chantiers*, but I can affirm, that in the matter "of perfection of execution, we rival the work of the English dock-"yards.' . . . . . A few words on the guns of 100 tons. . . . . "We might mount them on board the 'Duperre'; it has been con-"sidered; but for the present we have given up the idea: we shall "reconsider our decision later. But we shall soon lay down two "vessels, the 'Formidable' and the 'Amiral Baudin.' These first "rate armour-clads are to be armed with three 100-ton guns. It "is therefore necessary to make provision for this armament." The Government speaker concluded with a defence of the work executed in the Government dockyards as against that of private firms.

Our space will not permit a fuller translation of the report of this interesting and important debate. All Officers who take an interest in the progress made by foreign navies will do well to peruse the ample account of it which the *Révue Maritime* contains.

LES METHODES DE GUERRE ACTUELLES ET VERS LA FIN DU XIXe SIECLE.[1]

By Lieutenant-Colonel Pierron.

Lieutenant-Colonel Pierron held an appointment as Professor at the École Supérieure de Guerre, or the French Staff College, in 1876–77, and his book consists of the lectures he gave during those years to the Officers studying under him. The work comprises two large volumes, which are to be supplemented by a third.

To explain the spirit in which the work is written, the author gives extracts from four documents, the two shortest and most interesting of which we quote verbatim:—

"Primitive principles are derived from experience. In the same "manner that a masonry arch exists only by itself after the wooden "centering has been withdrawn, so also principles appear to rest only "on themselves when the experience from which they result is no "longer present to the mind."

Extract from a conversation of Napoleon I with Senator Roederer, March 6th, 1809:—

The Emperor.—"The King (Joseph Napoleon) is not laborious; the "least work overwhelms him. I am always working, and I meditate "a great deal. If I appear always ready to answer for everything "and to meet everything, it is that, before entering on an undertaking,

[1] Paris: Dumaine, 1878. Size of each volume about 7½″ × 5″ × 2″. Weight of each volume 1 lb. 8 oz. Pp. 733 and 921. Price 12 francs.

"I have meditated for a long time, and have foreseen what might "happen. *It is not genius which reveals to me suddenly, secretly, what I "have to say or to do in a circumstance unexpected by other people; it is "reflection, it is meditation.*"

Colonel Pierron informs us that his book should be read in the first instance and consulted afterwards, and, further, that on service it would be sufficient to read the "general principles" only. We may add that for this purpose the "general principles" should be embodied in a small pamphlet by themselves, as the two volumes would be too cumbersome to form part of an Officer's field kit.

Each chapter consists of two parts: first, the general principles; second, a number of well-selected examples in support of them; these general principles are those which are usually accepted by the military profession, or have been deduced by the author from the examples he gives. Amongst the examples we find numerous extracts from the writings of Napoleon, Wellington, and Washington; the opinions of Davout, Kellerman, Berthier, Marmont, Sir W. Napier, General Craufurd, and other leading Generals of the early part of the century are often quoted. Coming to more recent times, frequent reference is made to the writings of Marshals Vaillant, Bugeaud, Randon, and Canrobert, of Generals Todleben, von Moltke, the Archduke Albert, Sherman, von Schellendorf, Trochu, and Chanzy, &c.

The only remarks made by the author are contained in the short and temperate exposition of the general principles which he lays down. The work furnishes materials which would be useful in the preparation of a code on the international law of war. In the event of our sending an Army into the field, some general instructions on the subject would have to be issued probably for the guidance of our Officers. At the commencement of the Turco-Russian War, the Russian Government issued a catechism on this subject for the use of their Officers, but it is believed to have been of too technical and extended a character to have been of much real practical use.

The headings of the five chapters into which the work is divided are as follows:—1. Conditions to be fulfilled in order to command; 2. Organization; 3. Relations of the General-in-Chief with the Minister of War; 4. Organization of head-quarters; 5. Relations of the General-in-Chief with his Lieutenants. These several subjects are considered in their most comprehensive sense. For instance, Chapter I gives extracts from various authorities, regarding the nature of the studies to be undertaken recommended by Napoleon, and of the course of study pursued by Wellington. The chapter then continues with examples of firmness of character, of the training necessary before holding a command, of the dangers of the system of seniority, of the obligation to never capitulate, and, finally, of examples of the disbandment of troops rather than their surrender to the enemy. As regards the training which is considered essential for high command, we cannot do better than quote an extract attributed to the Archduke Albert, whose ideas on the proper distribution of responsibility are so well known and so worthy of admiration:—

"Those are small minds which in peace time excel in details, are

" occupied from morning to night in minutiæ, are inexorable regarding " the absolute correctness of uniform, of the dressing of lines, and of " the proper handling of arms, and who interfere at every instant in " the functions of their subordinates. They thus obtain an unmerited " reputation, and make the service a burden; but they are especially " mischievous in preventing the formation of character, and in hinder- " ing the advancement of capable and spirited Officers.

" Should a war break out, these little minds, worn out by their " occupation of details, are incapable of any effort; they fail miserably. " This is the everlasting story."

Regarding the obligation of Officers in command not to capitulate, very interesting examples are given. First are mentioned instances of capitulations, as warnings of what should be avoided, and afterwards examples are given which furnish glorious models for imitation.

Napoleon is quoted when referring to the capitulation of the Prussian General Finck, at Maxen, in 1759, as laying down a rule under which Officers are exonerated under certain circumstances from obeying the command of a superior. It appears on the occasion in question that General Wunsch with the cavalry had forced his way through the surrounding enemy; one of the conditions of the capitulation was, that he should return to the camp and lay down his arms, and he was weak enough to obey the order to do so given him by General Finck. This was a misconception of military obedience; *a General in the power of the enemy is no longer in the position to give an order; he who obeys him is criminal.*

In the act of accusation brought in 1812 against those who took part in the capitulation of Baylen, the General of Division Vedel was arraigned for complicity:—

" For having recognized the authority of a General who no longer " had orders to give him from the fact that he was surrounded by " the enemy, and had consented to an armistice before the arrival of " him, Vedel, on the field of battle, and was no longer free."

A long account is naturally given of the capitulation of Baylen, but it seems curious, with so many examples taken from the Peninsular War, that no mention is made of the Convention of Cintra.

A very excellent report is furnished of the breaking out from Almiéda of the French troops besieged in that town, by the British forces, during the Peninsular War. The statement of General Brenier, who was in command, shows that he took the proper steps for rendering the works and their armament useless to the enemy, before he marched out of the place, and forced his way through the investing army. The account rendered by the Duke of Wellington to Lord Liverpool, which substantiates the French report, is also given.

Colonel Pierron's book should be studied with interest, as it undoubtedly will be, not only by military Officers, but also by army administrators. The latter will find one subject of special interest, and that is the necessity of securing for their country an ample supply of firearms.

The Turks must be given great credit for foresight in this important

matter, when making their preparations for the late war, for they provided themselves, not only with an ample supply of small arms, but they took care that they should be of the best description. A country cannot be considered in a state of safety, unless supplied by its Government with a sufficient reserve of arms. As long as a nation has arms the struggle can be continued; in 1814 and in 1870, a scarcity of firearms interfered with a proper resistance on the part of the French, and, in the American War, the Confederate States suffered from a similar cause. We find, from the examples given by Colonel Pierron, that Napoleon was constantly writing to his Minister for War regarding the want of arms. In a communication, dated April 22nd, 1807, he remarks that nearly 10,000 arms had been lost in the battle of Austerlitz; these were broken by shot or rendered unserviceable by accidents in firing, thrown away by the wounded, and mislaid by the men sent to hospital.

In June, 1813, he writes again to the Minister for War:—"The "battle of Lutzen and that of Bautzen have cost us 40,000 mus- "kets; I estimate that we require at least 30,000 of them; 15,000 "should be sent to Erfurt, and 15,000 to Dresden." The French, after the Crimean War, came to the conclusion that 100,000 stand of arms had remained unavailable, being scattered in hospitals, ambulances, and regimental magazines. In the report made to the French Assembly in April, 1873, relative to the enquiry which had been made on all war material, it is stated that the war of 1870–71 caused to France the enormous loss of 7,234 guns, of all descriptions, and of 665,327 Chassepôts, without counting 500,000 old pattern arms.

There are many articles of equipment and stores which, with plenty of money available, can be bought in the open market, at the time they are required. This would not, however, be the case with arms, which require time and care in their manufacture, and of which no large supply is maintained in peace time, by private firms. Whenever this country goes to war, we shall always have to maintain a large number of foreign troops. This was the case in the Crimea, and in all our Colonial expeditions we have almost invariably raised a strong force of native auxiliaries. Considering that we should have to provide arms for all these foreign troops, and also to make good the losses sustained by our regular army during active operations, this country should certainly have a larger reserve of arms in proportion to the strength of its land forces than would be necessary for other European Powers.

Leaving the subject of firearms, to take it up further on, in Chapter V, from another point of view, the author next gives extracts having reference to a proper supply of boots. The first is taken from the writings of Field-Marshal Sir John Burgoyne, and is as follows:— "The Duke of Wellington was asked one day what was the first "requirement of a soldier. 'A good pair of boots,' he replied. "'And the second?' 'A good pair of boots as a change.' 'And the "'third?' 'A spare pair of soles.'" General Canrobert appears, in spite of all his endeavours, to have experienced a very great difficulty in keeping the French Army in the Crimea properly supplied with

boots, for, in January, 1855, we find him writing as follows:—"Not-
"withstanding all I have been able to say and do, we shall be at an
"absolute loss for shoes and boots."

Chapter IV, which treats of headquarter arrangements, refers, first of all, to the necessity of giving distinct names to the different headquarters. The author then quotes largely from von Schellendorff, regarding their composition. Next is pointed out the inconvenience of admitting volunteers and inexperienced Officers to the headquarters. Under the head of "Choice of Officers for the Staff," some valuable extracts, from the writings of the Duke of Wellington, are given.

The following extract from General Jomini refers to the method of working of Napoleon. "The Emperor Napoleon was himself the real
"head of his Staff. Provided with a compass, open to a scale of from
"7 to 8 leagues (which supposes always from 9 to 10 leagues, at least,
"by the sinuosities of the roads), leaning and sometimes lying on his
"map, where the positions of his army corps, and those presumed of
"the enemy, were marked by pins of different colours, he ordered his
"movements with an assurance of which it would be difficult to form
"a just idea. Moving his compass quickly over his map, he judged,
"in the twinkling of an eye, the number of marches necessary for each
"of his corps to arrive at the point where he wished to have it on a
"named day; then placing his pins on these new sites, and com-
"bining the quickness of the march which it was necessary to assign
"to each of his columns with the possible epoch of their departure, he
"dictated his instructions, which alone would be a title to glory."

The author next refers to authorities on the subject of the details of organization of a headquarters, in *personnel* and *matériel;* on the lodging of the headquarters, regarding which he gives an extract, explaining an ingenious system employed with the Army of the Potomac in the War of Secession, which, by the use of certain flags, of different colours and form, made it possible to at once recognize the army corps, Division, or brigade, where one happened to be, as well as any particular department which might be required.

The chapter concludes with information regarding the transmission of orders by mounted orderlies, escorts, and carriages.

In Chapter V, which, as above stated, refers to the relations of the General-in-Chief with his Lieutenants, we find some very interesting information under the heading of "Measures to be taken for Preserving
"Arms and for Preventing a Waste of Ammunition." Two extracts having reference to a subject previously referred to, namely, the loss of arms during a campaign, we give verbatim.

"*General Order.*

"Castro Xeres, 11th June, 1813.

"The Officer commanding any body of troops which has been
"engaged with the enemy, should, as soon as possible after an engage-
"ment, send an Officer with 20 men to the scene of action, to collect
"the arms, equipments, and other useful objects belonging to the
"regiment.

"(Signed) WELLINGTON."

The second extract is as follows:—

"Colonel Réné to General Soleille, commanding the Artillery of "the Army of the Rhine.

"Paris, 21st July, 1870.

"Allow me to draw your attention to one of the most serious "questions which can be raised during the campaign which is about "to commence. Being at the Ministry of War during the Crimean "War, I kept an account with the greatest care of the arms which "left France, of the arms which came back, of the produce of repair- "ing workshops with the Army, &c., and this is the general result:—

"To maintain 150,000 men in the Crimea we had 300,000 arms "employed whilst the war lasted, that is to say, 2 rifles per man. "This was because all the reinforcements sent to the Army were dis- "patched armed, whilst the sick returned to France without arms, and "that the arms of men who died remained in the hospitals or in the "small magazines of corps, so that at a certain moment 100,000 arms "were thus scattered about in all directions, and were deteriorating "daily until the time that General Auger, having perceived this, "caused the whole to be sent to France, where, in two months, our "manufactories put the greater part of this material into good order. "I believe that General Auger organized a special service of some "Captains, whose duty it was to discover everywhere arms which "were not being used and to collect them in the park. If one waits "until the corps or the hospitals return them of their own initiative "one gets nothing.

"The total loss of arms in the Crimea did not exceed 20,000, but "France was actually deprived of 150,000 arms during the war, and "if there had been troubles to contend with in another direction, we "should have been embarrassed.

"To-day the number of arms employed will be much more con- "siderable, and the supply of them is much more restricted, since it "consists of only 1,100,000.

"I think, then, that it will be most advantageous to disengage, so "to say, every day the army of arms repairable and not in use and to "send them back to France. I have warned the factory of Saint "Etienne to be ready, and it will be possible, if the Minister gives the "order, to prepare there a workshop for the repair of 20,000 arms per "month, when the time shall come.

"To establish workshops for the repair of arms in the parks, is, in "my eyes, a great fault, it encumbers us with material and causes "men to be employed with no satisfactory result. By sending "quickly to France all repairable arms, it will be possible to demand "new arms without danger, because the factories for repair can renew "the supply in a corresponding measure. The proximity of the "theatre of war will render this measure very practicable.

"The observations which precede being the result, not of private "opinions, but of the observation of facts which have recently "occurred, I have thought, General, that it might be useful that I "should lay them before you.

"P.S.—It must not be lost sight of, that during the course of a

" war, it is not with the army, but *at the depôts of corps* that it is " necessary to deliver arms. There is no object, therefore, in establish- " ing factories for repairs on the frontier as is generally believed. On " the contrary, it is in the centre of the country that they should be " placed."

The loss of arms on the battle-fields of the Russo-Turkish War did not pass unnoticed by the Russian military authorities, and we find in the *Voïennyi Sbornik*, for June, 1871, under the heading of " Some " Practical Conclusions from Our Last War," by Major-General Baron Zeddeler :[1]—" It is not possible to pass over in silence two series of " facts which were apparent during the last campaign; one which has " been brought to notice by Lieutenant-Colonel Kouropatkine, has " reference to the arms of the dead and wounded left on the field of " battle, and which were not collected because no steps had been taken " for that purpose. The other concerned the soldiers who, in great " numbers, threw down, during an action, their havresacks with " biscuits and their great coats, although they had been considerably " relieved by being disembarrassed of their knapsacks."

The next section of Chapter V points out the necessity of issuing orders for the prevention of the immobilization of the rolling stock of railways and of altering the time tables. The French intendants during the last war frequently kept their supplies in railway waggons, with the twofold object of having their property stored and of its being ready packed to be sent off at a moment's notice. The result was that the lines were constantly blocked and a large proportion of the rolling material rendered unavailable. Even in the German Army there was a great tendency to retain provisions in the railway waggons, but the " Commissions of Lines " exercised an energetic supervision and insisted upon the waggons being unloaded.

In a subsequent section, the question of communicating with the enemy, of receiving *parlementaires*, and of concluding a suspension of arms, is treated of. We extract orders given by Napoleon and Wellington on this important subject.

" 19th October, 1806.

" *General Order.*

" The Emperor expresses his dissatisfaction with the General of " Division, Klein, and with the General of Brigade, Lasalle, and His " Majesty orders that this mark of dissatisfaction with these two " Generals shall be published in a General Order, in that they " allowed two columns of the enemy which were cut off to pass, both " having been so simple as to believe what the enemy's General, " Blucher, told them 'that there was an armistice for six weeks.'

" Since when has His Majesty caused his orders to pass by the " channel of the enemy?

" The Emperor flatters himself that similar errors will not again be " committed. Military laws require the most severe punishment " against Officers in such a case; but the most serious punishment for

[1] A translation of this is given in the " Revue Militaire de l'Etranger."

" an Officer of the Grand Army, is not to have contributed in every " point to the entire success of the operations.

" MAJOR-GENERAL BERTHIER."

" Celorico, 1st August, 1810.

" 1. The following rules will be observed in communications with " the enemy.

" 2. No flag of truce will be sent to the enemy without the autho- " rization of the General-in-Chief.

" 3. Every letter to be sent with a flag of truce must, in the first " instance, be seen by the General-in-Chief.

" 4. The bearers of flags of truce sent by the enemy will not pass the " advanced post where they present themselves. The Officer com- " manding this post will deliver them a receipt for their letter and " will then send them back.

" 5. The Officer receiving the bearer of a flag of truce should not " enter into any conversation with him, he should confine himself to " giving him a receipt and then sending him away."

The instructions regarding flags of truce contained in Part V of the Field Exercise, although not so comprehensive as the rules promulgated by the Duke of Wellington, are evidently based on them.

We give also two extracts regarding the obligations to retain any *parlementaire* who may present himself during an engagement or movement of troops.

" Wellington, Commanding-in-Chief the English Army, to Massena, " Commanding-in-Chief the French Army.

" Headquarters, 11th May, 1811.

" Captain Salles, of the 66th Regiment, has been sent as a *parle-* " *mentaire* to the outposts of the Allied Army during the night of the " 3rd of this month, by the Colonel of his regiment, in a very " irregular manner and at a very unusual hour. I have considered " it my duty to retain him throughout the duration of the state of " affairs which existed at that moment. But being convinced that he " has really been sent as a *parlementaire*, although under very " irregular circumstances, I send him back to the French Army."

" Wellington to the French General Count Gazan.

" Headquarters of the English Army,

" 10th November, 1813.

" At the moment of the arrival of Lieutenant ———, at my head- " quarters, the Army was commencing its movement, and I did not " think it proper to allow him to re-pass my outposts under such cir- " cumstances.

" I take advantage, therefore, of the first opportunity which has pre- " sented itself to send him back to the French Army."

Section 4 of Chapter V, reference to which appears to be omitted in the table of contents, treats of the improvements to be introduced in the organization by the General in command. We think in this case the author goes too far in his proposals, and he confounds the functions of the General Officer with those of the Minister of War.

He begins this section by laying down that a General on assuming command should introduce into the organization of the Army, if they do not already exist, certain improvements, some of which could not certainly be undertaken on the eve of active operations, and which are matters for Government decision and beyond the competency of a General commanding.

For instance, he proposes as regards the infantry that all the men of minimum height should be transferred to corps destined for garrison duty; that the soldier's knapsack should be lightened by having his change of clothes carried on waggons; that each brigade should be provided with a waggon carrying spare soles, leather, and sewing machines, so that shoes could be mended at a moment's notice. As regards the artillery, the General is recommended to withdraw the carbines from the gunners of field batteries, and although this and other recommendations may be sound in principle, they appear to be somewhat beyond the province of a General appointed to a chief command. Many useful hints are undoubtedly contained in the general principles placed at the head of this section. For example, it is recommended that cavalry regiments should be provided: 1st. With a table showing the uniforms of the enemy's Army, with an explanation of the distinctive signs of regiments, brigades, Divisions, and army corps. 2nd. The composition as far as known of the hostile army, with an indication of doubtful points to be rectified in reconnaissances. 3rd. Maps of the theatre of operations.

The documents which the author gives to be consulted, commence with the following:—

" Every progress is condemned to pass through two phases.
" First of all it is denied; it is absurd!
" Afterwards it is despised; that is well known; it is old; every-
" one said that; we knew it well.

" LE COMTE DE GASPARIN."

In support of the proposals the author makes to reduce the load carried by the infantry soldier, he quotes Marshal Bugeaud, who when in command of an expeditionary column in Algeria, described in one of his letters to the Minister of War the load of the infantry soldier as simply barbarous. Quartermaster-General Rufus Ingalls, of the United States Armies operating against Richmond, states in a report to the Minister of War, that the proportion of men who threw away their knapsacks on service was 25 per cent. General Fiéreck in evidence he gave before the commissions of enquiry of the National Assembly in August, 1871, states that to the regiment of Lot et Garonne, it was necessary in 1870 to distribute knapsacks and tents twice within the space of six weeks. We give the following extracts from the writing of a Captain of Prussian infantry, *in extenso*, as perhaps it is not generally known that it was a practice with the Prussian Army in 1870–71 to order the men to remove their knapsacks before fighting. " To make the infantry fight with the knap-
" sack on is to render it impossible for them to execute rapid move-
" ments, to carry a position with a rush, and to forestall the enemy at

" an important point. As soon as the action commences, or even that it " becomes certain to take place, one object only must be kept in view : " that of conquering and to give oneself immediately every possible " chance of success. The knapsack should then be taken off and the " soldier should take with him only his arms, cartridges, bandage, " havresack with food, water bottle and cooking vessel. He will " keep his great coat in a roll over the shoulder. The knapsacks will " be left by company or battalion, near villages, ambulances or parks, " or in a barn, or church, &c. If the enemy is beaten the knapsacks " are refound; in keeping them one would have been deprived of " the freedom of one's movements or else of many men whom fatigue " would have caused to remain behind. If the battle be lost the " knapsacks would have been lost in any case, for men, whether they " have fought or not, if they have their knapsack, throw it away " during a retreat."

In the war of 1870–71 the conviction was so general in the German Army that to fight with the knapsack on, gave such a small chance of success, that they had arrived at the habit as soon as a combat was inevitable, of leaving the knapsacks in charge of footsore men with the intention of causing them to rejoin afterwards on requisitioned waggons.

As a great deal has lately been done in this country to complete the supply of regimental and other carriages for an army taking the field, the following information on this subject will not be without interest :—

" Latterly (1871) endeavours have been made in the Austrian " Army to reduce the number of carriages as much as possible. One " of the measures taken with this object has been to transform the " draught of four horses of all the old provision carriages to a draught " of three horses abreast, which has given not only an economy of " one-quarter in the number of animals, and of the quantity of forage " to be delivered, but also has reduced by six paces for each carriage " the length of the waggon trains. Lastly, the system of driving with " long reins has been adopted."

" A second measure has been the introduction since 1867 of a new " carriage to which the horses can be harnessed either in front or " behind, so that if one is obliged suddenly to retire, it is not neces- " sary to turn the carriage round, which moreover is often impossible " in narrow roads; it is sufficient to bring the horses with the pole " from the other side, that is to say, to change the side of the draft. " Moreover, this new carriage possesses the great advantage of taking " to pieces entirely.

In drawing attention to the Austrian arrangement of harnessing three horses abreast, it is not in any way suggested that we should follow their example in this respect. Three horses abreast probably answer very well on the broad *chaussées* of central Europe, but they would be unsuitable to the narrow roads of England, and it is doubtful if they would be of any advantage on the badly kept highways of Turkey, or the unmetalled tracks of Asia Minor.

Whilst on the subject of carriages, it is well to give the following

extracts regarding two-wheeled carts, as carts of this description have lately been introduced into our service for the transport of the first reserve of regimental ammunition, although it is not intended they should be used in very mountainous countries; in this case mule transport would be employed.

"Extract from the Journal of the Chief of the Staff of Martin's "Column, in the province of Durango (Mexico), June, 1864.

"Carts with two wheels travel generally very well on a plain, and "demand a less effort of traction than waggons with four wheels, on "ground almost flat; but it is quite otherwise in hilly countries. "There, if there is only one draught animal it has to support a part "of the weight, which is greater according as the slope is steep, and it "has also to overcome the friction. But what renders carriages of "this description especially unfit during war, is, that they are always "overladen, or else their load is badly balanced, in descents the "centre of gravity tends to overwhelm the horse, in ascents to raise "him and to prevent his taking firm hold of the ground so as to work "well up to the collar."

"Extract from the 'Journal of Marches and Operations of the "'Artillery of the 5th Army Corps, in the Campaign of 1870.'.

"Our march on the night of the 6th and 7th of August, from Bitche "towards Petite-Pierre, by roads through the woods in the neigh- "bourhood of Petite-Pierre, had been singularly retarded by the "difficulty experienced in getting the infantry two-wheeled carts over "awkward places: this cart and the baggage carts of the Officers are "the least mobile of all the field material, including the carriages of 12.

"LE COLONEL D'ARTILLERIE DE FENELON."

In March, 1876, the Minister of War, in Russia, decided that the ammunition carts with two wheels should be replaced by carriages with four wheels.

The next point, which, at the present moment, is interesting to ourselves, is the remark of an Officer of Prussian infantry regarding their helmet. It is as follows:—"I consider the headdress used by "our infantry in Prussia as unfit for active service. It is necessary, in "fact, that a headdress should be convenient and light, that it should "protect against the sun and rain. Our helmet fulfils the second "condition, but in no manner the first. It does not permit of firing "at all when lying down; and the reflection of its metallic ornaments "betrays from a distance the presence of troops. We have thoroughly "recognized its inconvenience under many circumstances; thus during "all the siege of Paris (1870–71) our soldiers carried it not on the "head, but suspended from the handle of the sword. We should do "better to replace it by a headdress with a peak of solid material, like "the Austrian képi."

Although our helmet is undoubtedly an improvement on the Prussian model, we have, nevertheless, retained in the bright metallic ornaments the most glaring defect of the original. This is a defect

easily remedied, as is shown in the case of the Rifle Brigade, by having the ornaments bronzed, and this would probably have to be done for all infantry employed on active service. It would be inconsistent if we carefully instructed our troops so to take cover that they may be unseen by an enemy, and at the same time placed bright ornaments on their headdress to render them strikingly visible at a long distance.

Section 5 of this chapter treats on rules of correspondence. The Duke of Wellington is largely quoted in the extracts given, and the "general principles" deduced from these extracts appear so worthy of attention, that we copy them as they stand, from the original.

"*General Principles.*

"As a general rule written correspondence should be forbidden "between Officers and others who are in a position to settle their "business verbally; disputes as to informalities are thus avoided; "the Chiefs are spared the trouble of reading voluminous documents, "and their Staffs are dispensed from making copies of them.

"On the other hand, it is necessary to insist when heads of de- "partments cannot themselves render a verbal account of important "affairs, military operations, information regarding the enemy, &c., "that they should report to the General-in-Chief in writing, even "should they send a messenger to inform him verbally, because the "manner of relating a circumstance indicates what importance and "what significance is attached to it.

"To exercise the command of the Army based on sufficient infor- "mation, the General-in-Chief should personally receive statements "showing the effective and disposition of the troops, indicating for "how many days they are provided with food and ammunition, and "their requirements; it is necessary also that all information regard- "ing the operations and the enemy should be sent to him without "delay, for on them his resolutions are based. The commanders of "corps on the march will send him in advance their itinerary day by "day, so that it may be known where to send orders to them. As "regards documents having reference to purely administrative "matters (such as referring to *personnel*, discipline, &c.), they should "be addressed direct to the Chief of the Staff.

"Signatures for the most part being illegible, it would be advisable "to return to the rules in force under the First Republic. At this "period the name of the writer, and of the person addressed, were "written in full at the head of the document in the following "manner:—*General of Division N commanding* [*such a body*], *to the* "*General-in-Chief M commanding* [*such an Army*]. These indications "were even often printed beforehand. In this manner there could be "no doubt as to who the letter came from, for the name, the rank, and "the employment were stated *in extenso*. It would be well also to "prescribe, as in the Army of the Rhine, in 1870, the suppression of "ceremonious formulas, except in relations with the Navy, with allies, "and with the enemy. Faults should be noticed or censured in "language which is not insulting.

"At the head of every letter should be written the place, the date

" of the day, and the hour. Without the indication of the hour it is " impossible that the person who receives the letter can comprehend " the succession of facts which during the same day has occasioned " several letters: for it may happen that a written report, carried by " a mounted orderly, arrives at its destination after a telegraphic " communication, which, however, has been sent off later, and which " makes known facts which have occurred since the despatch of the " report. These errors can only be avoided if every report or tele- " graphic message mentions the hour that it was drawn up. As re- " gards the name of the place, if it is a very small locality, which " runs the risk of not being shown on the small scale maps used by " the General-in-Chief, it is necessary to put with it in parenthesis " the name of the nearest town. If reference is made to a map the " title and scale of it should be mentioned. Nothing, however, " explains more clearly than attaching a sketch to a description.

" After the indication of the place, the hour, and the day, it is " necessary to give to the letters a serial number, which will enable " the person to whom they are addressed to know if any are missing. " The answer or acknowledgment will mention this serial number, " and will give a *résumé* of the order received, to show if it has been " well understood. If the serial number shows that a letter has been " lost, a copy of it will be sent, or will be asked for.

" For the sake of clearness every letter should be divided into " paragraphs numbered; the first will acknowledge receipt of the com- " munication; the second will demand any explanation that may be " necessary; the third and following will detail the measures taken " in consequence for each arm and for each department. It is besides " very useful to treat only of one subject in one letter.

" Every letter should be complete in itself, and dispense, as far as " possible, with reference to other documents. Thus, if a law or a " regulation is cited, the article in question, or the substance of it, " should be given. A description of localities or of the disposition of " troops can be advantageously completed with a sketch; but in this " case it is necessary to see carefully that the details of the sketch " correspond with the descriptive text. In making a report to a " superior, it is necessary to add whether or not his opinion is awaited, " so as to avoid contradictory measures and orders followed by counter- " orders which alienate the confidence of the troops.

" In general a graphic, simple, and concise method is preferable to " long explanations. Thus, a precise 'state' is more valuable than a " prolix report, for it condenses in a few columns the losses and gains " of the effective. Napoleon preferred it to the jeremiads of com- " manders of corps on the losses they wished made good, for the com- " parison of these 'states,' the day before and the day after a combat, " show at once the losses, the numbers remaining effective and in- " effective, &c.

" Every communication should contain only precise statements. " The employment of vague expressions, such as *detachment, immense,* " &c., should be avoided. As a rule we should photograph facts, and " not paint pictures. It is necessary to give the number of the corps,

" the composition and contents of convoys, the road followed by the " troops, and the hour at which the facts have been accomplished. " The orders executed must be distinguished from those which have " been simply given, and the realization of which is not yet assured. " If reference is made to artillery or ammunition, the calibre must " be stated. Without this precision the most urgent reports often " cannot be made use of.

" It should be published in orders that every demand must show :—

" 1. From what time.

" 2. At what place.

" 3. In what quantity.

" 4. With what means of transport.

" 5. For what destination.

" 6. Under whose responsibility will be made the delivery, the " reception, the custody, the transport, &c. If a detachment is " referred to, mention must be made as to how the men will be fed, " and what their effective will be."

" In granting a demand, the following should be mentioned :—

" 1. Where, when, and for how long.

" 2. If the magazine, or the authority that is to deliver, has been " warned.

" In the same way it is always advisable in bringing inconveniences " to notice to show :—

" 1. The remedial measures considered necessary.

" 2. The orders and recommendations to be given and to whom.

" 3. Where objects can be found to replace them.

" *Telegraphic despatches.*—The telegraph is not a sufficiently safe " means of communicating in the field ; it is necessary, therefore, to " confirm despatches in writing, especially if they are in cypher, for " one error in the transmission of a cypher is sufficient to destroy the " sense of a sentence. It is above all necessary not to make an abuse " of abbreviations in serious communications, and to have always " available a key to the cypher correspondence."

The next section of this chapter is on the preparation and execution of orders. It appears that Napoleon, Wellington, and the Archduke Charles have laid down, in almost identical terms, that a military order requires passive obedience only when it is given by a superior, who, being present at the moment he gives it, is acquainted with the actual state of affairs, and can listen to the objections and give explanations to him who is to execute the order.

It, therefore, appears that an Officer is justified in acting according to his own judgment, when he receives an order which, owing to circumstances, not known to him who gave it at the moment of giving it, would be impossible to execute, or the execution of which would be disastrous. The evil of giving counter-orders is animadverted on strongly, and the harm that is often done in giving orders precipitately is pointed out. Instances are cited of the issue of orders which have been impossible to execute, owing to a proper calculation not having been made of the time necessary to carry them out. The necessity of clearness, decision, and completeness in the preparation of orders is

insisted on; the utility of informing commanders of adjacent corps of their reciprocal tasks is pointed out, and, lastly, the relations between the General and his Staff Officers are laid down.

The 7th and last section of this chapter is on marches, which are considered under the following headings:—

Combined march of several armies under the orders of one Commander-in-Chief; march of an isolated army; Cavalry exploring in front of an army; march of the *gros* of an army; marches of Army Corps; marches of Divisions, brigades, and detachments; prescriptions for columns of all descriptions; numerical data regarding marches.

Besides laying down general principles, types for an order of march in each case are given, and numerous examples, many of which are taken from the American War, are furnished.

Under the heading of "Measures for Diminishing the Fatigue of "Troops on the March," we find a compilation of the orders given during 1809–10–11, by General Craufurd, then commanding the light Division in the Peninsula, and Colonel Gurwood's account of the practice followed by the English Army in Portugal and Spain in 1808–1814. There is also an extract from the general order given by Sir Henry Fane, Commander-in-Chief in India, at the opening of the first campaign in Afghanistan: this order can hardly have been quoted as containing any new or very valuable instructions, as it appears to have been issued merely as a sort of reminder regarding the discipline which should be maintained on the line of march.

There are several extracts from the works of General Lewal, who has lately written a great deal on marches, a subject to which he has given very close attention. We give two of these extracts, as, although owing to our not having to deal with large masses of troops in the British Service, they may not be considered of very great practical utility, they will, nevertheless, be useful to a certain extent, and will certainly be interesting to the students of military history. The same principles should, however, undoubtedly be attended to by our Staff when arranging a march of even small columns of troops, for it will be found that any extra study or trouble that may be incurred, in so arranging movements as to save the troops all *unnecessary* fatigue and discomfort, will be well repaid by the better condition in which both Officers and men will be maintained, and by the increased readiness with which they will be prepared to undergo very severe fatigue, when the necessity for it really arises. General Lewal says:—"It is necessary to be well aware of the extent occupied by "troops on the march, their quickness of marching, and the time they "take to traverse specified distances. Appreciations on this subject "have remained to the present day very vague and very dissimilar. "The results have been grave errors and serious military faults, some-"times placing columns in perilous situations. Thus, arrangements "have been made for the departure of Divisions every half hour, when "four times this period was indispensable. This was an hour and a-"half of fatigue uselessly imposed on the second Division and double "that amount on the third. Columns have been made to arrive at a "defile two or three hours before the completion of the passage by

" the preceding column, in consequence of not knowing the length of " the columns and their quickness of march. A Commander-in-Chief " has been seen to engage his whole army (150,000 men) on a single " road, believing that he would accomplish the distance in fifteen " hours, whereas four or five times longer was necessary. Serious " embarrassments have been the result; these would have been avoided " by a knowledge of the practical conditions for the movement of " masses.

" Sometimes an action has been commenced with the heads of " columns, and then there has been astonishment at not seeing the " remainder appear as soon as was supposed. Order after order has " often been sent to hurry on the movement of troops, as if it had " been possible to quicken the pace of large masses.

" When the order of departure arrives at the Army Corps, forty- " five minutes are necessary on the average to send it out to " Divisions; from these latter to brigades thirty minutes, and from " brigades to the different corps about fifteen minutes. It is to be " understood that this transmission is limited, in causing to be ordered " as rapidly as possible. 'You are to march;' this is the first order to " be given, the instructions will follow afterwards.

" The transmission requiring an hour and a-half (1 hour 30 min.) " and the preparations for departure one hour, it is evident that on an " average the column will commence its movement two hours and a- " half (2 hours 30 min.) *at the soonest* after the reception of the order " at the Army Corps, and often much later.

" Here are two examples:—

" The 30th August, 1870, the day of the Battle of Beaumont, the " first Bavarian Corps received at Sommerance, at 3 hours 30 min. in " the morning, the order to advance by Sommauthe. It started " only at 6 o'clock. Consequently two and a-half hours had been " necessary. This was too long in this particular case, for the order " arrived precisely at the hour when everything ought to be ready for " a start, and besides the Army Corps was united together. From these " two causes it may be concluded that there was at least one hour lost.

" The second fact is this:—The 3rd July, 1866, the Prince Royal " commanding the second Prussian Army, received the order of the " King (the General-in-Chief) to commence moving so as to take " part in the Battle of Sadowa, at 4 o'clock in the morning. The " troops started at the mean hour of 7 o'clock. It must be remem- " bered that here again it was the question of a morning start, that is " to say, at the usual hour when every one is present. Moreover, the " troops only were started on the march, and all the impedimenta " remained in the positions they occupied. Lastly, the entire Army " was concentrated, which rendered the communications very rapid.

" A departure during the day (that is to say, during the course of " the day) would not be accomplished with the same promptness for " the reasons given above. Care should, therefore, be had to take " account, in the considerations to be allowed for this delay, of the " two to four hours necessary for the head of a large column to get " into movement."

With the large masses of troops which are put in movement in the present day, the proper arrangement of halts whilst marching is a matter for serious consideration. The French have lately adopted the system of dividing the column of march into groups of equal length, separated by equal and considerable intervals. These groups halt independently at certain fixed hours for fixed periods, and by this means the necessity for closing up the rear of a long column when the halt takes place is avoided. The following extract, which shall be the concluding one we take from Colonel Pierron's book, clearly explains, in the words of General Lewal, the system to which we refer.

"In a column the halts cannot be long without increasing the "duration of the march, which has many inconveniences and, amongst "others, that of causing a late arrival at the bivouac. Men have "then insufficient repose and food badly prepared.

"Five minutes' rest every hour is generally considered sufficient, "but it is evident that, for the rear of the column to enjoy this rest "after having closed up to distance, the halt will naturally be pro- "longed to a greater extent at the head. Let us endeavour to calcu- "late what it ought to be in reality, admitting that by well-considered "measures the pace could be maintained at 4 kilometres.

"Let us consider, first of all, a battalion of 800 rifles in the ranks, "that is to say, an effective of 934 men. Its front, when deployed at "the rate of 0m. 70 per man, is 280 metres; this is the extent which "theoretically it ought, also, to occupy in column. The space result- "ing from the loss of distances, and the time necessary for the rear of "the column to make it up during the halt may be stated as "follows:—

"Prolongation.	Space lost.	Time to close up.
"$\frac{1}{4}$ of the length of the column	.. 70 metres	..... 1m. 13s.
"$\frac{1}{3}$ " "	.. 93 "	..... 1m. 25s.
"$\frac{1}{2}$ " "	..140 "	..... 2m. 26s.
"$\frac{2}{3}$ " "	..186 "	..... 2m. 50s.

"In these several cases, a halt of five minutes at the head might "suffice on an emergency, for, in the last case, the extreme left (the rear) "would have a little more than two minutes' rest, although it would "be almost illusory. If the prolongation doubled the length of the "column, the rear would employ 4m. 15s. to close up, that is to say, "the almost total duration of the halt. The last men would, in "reality, have no rest, or next to none.

"Let us now consider a regiment of three battalions. An analogous "calculation gives us—

"Prolongation.	Space lost.	Time to close up.	Duration of halt.
"$\frac{1}{4}$ of the length of the column	.. 210 metres	.. 3m. 39s.	.... 9 min.
"$\frac{1}{3}$ " "	.. 280 "	.. 4m. 12s.	.... 9 "
"$\frac{1}{2}$ " "	.. 420 "	.. 7m. 18s.	....12 "
"$\frac{2}{3}$ " "	.. 560 "	.. 8m. 24s.	....13 "

"If the loss of distances equalled the length of the column, the "rear would employ 14m. 36s. to close up, and a halt of 20 minutes "would be necessary.

"When the prolongation does not exceed the half of the extent of "the column, a halt of 10 minutes might be suitable for a regiment "of three battalions. If the loss of distances were greater, 10 minutes "would no longer suffice, and it would be necessary to double the "duration of the halt.

"These figures are striking. I do not work them out any further. "It is easy to understand that, with a brigade, the elements of which "would close up at every pause to the head of the column, halts of 20, "30, or 40 minutes every hour would be arrived at. In the same way, a "Division with its artillery, its ammunition reserve, and its ambulance "would require halts of 45 minutes, 1 hour 10 minutes, and $1\frac{1}{2}$ hours "every hour. This shows, at the same time, the impossibility of this "system and the serious error committed in believing that rest can be "given to troops by pauses of 10 minutes, in strong columns. "Nothing of the sort takes place; *the greater number of the men never "halt at all, and it is this which, up to the present time, has been the "chief vice of all our marches.*

"In very strong columns, the Generals wishing to avoid this "excess of fatigue to their soldiers have caused halts to be made, "either by Divisions or by brigades, and the evil was partly overcome. "However, as these halts were in no way regular throughout the "whole extent of the column, and *especially did not take place at the "same time*, the result was either a solution of continuity when the "first portion continued marching whilst the following remained "stationary, or else an unexpected halt for the portion in rear, when "the portion in front came to a halt. These inconveniences clearly "indicate the imperious necessity of regulating these important "details. They demand, before all, two things—the relative inde-"pendence of groups in the column, and an instantaneous halt for "every one at the same time. It is possible that this second con-"dition may at first appear surprising. After giving it due considera-"tion, it will be recognised as indispensable, and I will show, in the "course of this study, that it is not difficult to obtain.

"A pause of 10 minutes after each hour of march augments the "time of the movement by one-sixth, that is to say, by two or three "hours for the duration of long stages. This augmentation of time "could not well be exceeded. As I have above explained, the grouping "which answers to the halt of 10 minutes is the regiment of infantry, "or a number of carriages of an equivalent extent.

"It would be a mistake to make the battalion independent, for the "result would not be so good. With strong effectives, a halt of 5 "minutes would not suffice. It would be necessary to increase it to "6 or 7 minutes, and the advantage would become very small. "Besides, the multiplication of the heads of columns would render "the organization, as well as the execution, of the movement very "difficult. In warlike matters, it is indispensable to be prepared for "the unforeseen, if one desires to be practical. Now, an imperceptible

" difference of pace becomes sensible at the end of an hour. If, then, " the head of a column loses or gains 50 metres, this would be a small " matter if the heads of groups are 1,300 metres distant, serious, if " only 350 metres. In the first case it would not be perceived; in the " second, a catastrophe would certainly happen. For these reasons it " is advisable, in big columns, to prefer the regiment group to the " battalion group.

" Every regiment will form, then, the head of a column, will main- " tain exactly the prescribed pace, and will make a halt of 10 minutes " at the end of every hour's march, acting absolutely as if it were " alone, with the exception of the restrictions noticed. It would be " easy to understand the possibility of this manner of acting if the " regiments were at several kilometres from one another. With " method and a little attention it is not more difficult to practise if " the regiments are nearer to one another, on the condition, however, " that each body of troops maintains the normal pace, and makes its " different halts at exactly the same hours. If the head of each group " marches at the same pace, and steps at the same time, there is no " reason why the movement should miscarry. Some Officers think, it " is true, that the chief of a column should vary the duration of the " times of marching and of halting according to the temperature, the " ground, the fatigue of the men, &c. This method, very doubtful for " a small isolated column, ought to be absolutely rejected for a series " of groups subordinated one to the other. In this case, an extreme " regularity is indispensable. Every day the chief of the column " gives the indications of the march, and every chief of a group " should apply them rigorously. Nothing is more simple than to " insert, in the order of movement, the indication of the hour of the " first hourly halt. Everyone knows that the pause is for 10 minutes, " that they ought to march for an hour, neither more nor less, and " traverse during that time a specified number of metres. That being " well known, the fractions will, of their own accord, make successive " halts at the same hours, and the whole of the movement will be " regular. There is nothing in this but what is very practical, with " watches regulated every day.

" There remains only to determine the distances to take at starting " off between the heads of groups, and to preserve these integrally " during the whole march. We cannot fix them theoretically because " we are ignorant of the true proportion of the prolongation. We " know that it will be a third or a quarter (of the length of the " group) at the least, and certain examples teach us that at times it " becomes much more considerable. A good method of marching, " rigorously applied, will undoubtedly restrain the losses of distance " in a very sensible manner. The chief of the column should take " account of the prolongation of his troops by attentive and sustained " observations during the first days of march. According to the results " obtained he will modify his instructions, so as to approach his " groups as much as possible without ever closing them so as to " deprive them of the necessary elasticity.

" For the first time, for example, a prolongation of one-half (of

" the regulation length of column of the group) may be taken as a " base. This condition admitted, subject to subsequent rectification, " it will be easy to deduce the distance to be observed between the " heads of regiments. It will be established as follows :—

" Three battalions at 280 metres ..	840 metres.
" Two battalion distances	40 ,,
" One regiment distance	30 ,,
" (Prolongation) loss of distance (half of the length)	420 ,,
Total ..	1,330 metres.

" The leading guide of the second regiment will keep himself then " at 1,330 metres from the one of the first regiment, and if he so main- " tain himself the march will be effected without difficulty or trouble " of any sort.

" The distance between the different groups must be taken with " great exactitude. It does not do to leave it to be judged, however " practised in estimating distances those concerned may be. The " safest method is time. To traverse 1,330 metres at the pace of " 4,000 metres an hour, 19 minutes 57 seconds are necessary, say 20 " minutes ; or at the pace of 3,500 metres an hour, 22 minutes 48 " seconds, say 23 minutes, are requisite. The second regiment will " consequently pass any point agreed upon 20 or 23 minutes after the " head of the first one.

" This initial point of the general movement of the column should " be a house, an inn, a bridge, or a remarkable tree near the exit of " the bivouac. The order for the movement will indicate for each " corps the precise hour and minute at which its head should arrive " at the initial point. Every Colonel causes the distance which " separates his bivouac from this point to be reconnoitered, and he " puts himself in movement accordingly. There is nothing in this " impracticable or even difficult ; a little foresight and attention are " sufficient.

" If this method were practised in peace time it would certainly be " possible to carry it out with such perfection in war, that it would, " perhaps, be possible to descend one degree, and to do for battalions " what I have just described for regiments. The business then becomes " more delicate without presenting a great increase of advantages. " As it is necessary to avoid everything which is complicated on " service, I think it is advisable not to push the system too far, and to " confine oneself to the regiment. But for this unity the preceding " method must be formally applied. The regularity and convenience " of the march would be enormously increased ; it is the only way of " reducing to the minimum the prolongation of columns, to carry out " the movement with less fatigue, and, lastly, to be able to increase " the length of the stages without jading the troops."

In conclusion, it may be stated that Colonel Pierron's book shows that he must have been a most diligent military student, and one who

has read with profit. He has known what to extract and to print for the benefit of others, and this careful compilation will prove of great assistance in the present day, when so much is written on military subjects, in enabling us to make use of the valuable information given by many authors, without having to wade through volumes of indifferent matter in order to discover it.

The third volume is to treat of the tactics of the three arms on the field of battle. The work will then in itself form a small military library. It is recommended without hesitation to all who are interested in military matters not only as a most useful book, but as an extremely entertaining one. We trust that in the next edition an index may be added.

C. J. East,
Major, 57th Regiment.

PRACTICAL EXAMINATION OF THE CATASTROPHE TO THE GERMAN IRONCLAD "GROSSER KURFURST."

By a former Naval Officer.

(Translated from the "Deutschen Revue," by Lieut. Carslake, R.N.)

The news of the loss of the "Grosser Kurfurst," on the 31st of May of this year, excited everywhere in our fatherland the greatest sorrow and horror. A quarter of a year has since elapsed. The occurrence has been criticised in the daily press from different quarters with more or less perspicuity, but the source which was alone in the position to give a clear and exhaustive explanation of the misfortune and its causes, namely, the Chief Naval (Authorities) Board, has been until now persistently silent. The first short report of the commander of the squadron on the collision, some official notices on the "Havarei Commission" (German Trinity Commission) and the finding of the court-martial, without any details of the cause itself, are all that the public have learned from the Admiralty. Added to this is the article in the *Weser* paper of July 7th, which treats of the matter in a peculiar manner and gives quite the impression of having been written by order.

All further facts we have had to collect with much trouble from the papers, principally English ones, and by degrees from verbal communications or letters from eye-witnesses.

Seeing the universal and deep interest which the misfortune possesses for the nation, we will examine the papers lying before us.

The brief account of the catastrophe is as follows:—

The three ships "König Wilhelm" (Post-Captain Kühne), "Grosser Kurfurst" (Post-Captain Count Monts), and "Preussen" (Post-Captain von Blanc, who is also on the Admiralty Staff and Head of the Naval Staff), were commissioned on May 6th, and were

fitting out until the 27th of May. They were formed into a squadron under the command of Admiral Bach, and had started on their cruise to the Mediterranean on the 29th May. On the morning of the 31st May, the squadron was near the town of Folkestone. They were steaming in double line of columns (ahead), *i.e.*, "König Wilhelm," and behind her the "Preussen," formed one column, while the "Grosser Kurfurst" formed the other, towards the English coast. The distance between the three ships at the commencement was 400 metres (440 yards); however, about an hour before the collision, the "Grosser Kurfurst" was indicated by signal to close her distance from the left column to 100 meters (110 yards), and had been steaming since that time in her newly ordered position.

About 10 A.M. a (cruizing) merchantman so approached the squadron, that, according to the international laws as to clearing ships at sea, the squadron was obliged to alter its course towards the English coast. The "Grosser Kurfurst" began also, according to these laws, her manœuvre first, and ported her helm in order to turn to starboard, *i.e.*, to turn to the right and pass astern of the merchantman. Whilst in the act of turning, the "König Wilhelm" followed with the same manœuvre.

When the "Grosser Kurfurst" saw the merchantman on her left hand, and, therefore, her course clear, she intended to continue in her new direction until the ship was passed, in order afterwards to take up her former course again. However, at this time she noticed that a second merchantman was approaching her in the same manner as the first one. In order to clear this one also, the Captain ported his helm again and turned in consequence still further to the right and the English coast.

Immediately after this manœuvre he noticed that the "König "Wilhelm," instead of turning concentrically with the "Grosser "Kurfurst," flew round so rapidly in a much smaller circle and ran towards the latter ship, that very soon a collision appeared inevitable.

Although Count Monts instantaneously had the helm put "hard a-"port," and the engines to full speed ahead, because herein appeared to lay the only, if but small chance of escaping the danger; but the "König Wilhelm" had already approached too near.

It is true that the latter, in sight of the threatening danger, put her engines "full speed astern," but as her speed was 9 knots ($2\frac{1}{4}$ German miles) an hour, she could not check it quickly enough, and she struck the "Grosser Kurfurst" with her ram. The only thing that the latter gained by her manœuvre, and what under the existing circumstances appears very important, was that by her turning, the blow instead of coming from the beam and right angles, came more at an angle and from astern, and in consequence lost in force. Had she been struck more at right angles, the immense moment of the colossal "König Wilhelm" probably would have cut her prey clean through, or else the "Grosser Kurfurst" probably would have sunk in a few minutes, like the Italian ironclad "Re d'Italia" at the battle of Lissa.

In consequence of the much weaker blow, 15 minutes elapsed before the ship sank and 200 men were thus able to be saved.

The saving was performed principally by the "König Wilhelm," who remained in the immediate neighbourhood of the sinking ship, though through the blow she was severely damaged herself and leaked dangerously, still she got the whole of her boats out and saved 140 lives.

The English fishing boats in the neighbourhood of the accident hastened to the spot and succeeded in rescuing about 60 of the ship-wrecked men. By the "Preussen" two men were saved.

That is the practical account of the catastrophe, and now we will notice special points more closely.

We have, therefore, to consider the question, "What were the direct "causes of the collision?"

The answer was, "The people at the helm of the 'König Wilhelm' "lost their heads in the moment of danger," and, as it is stated in the official publication concerning this point, "contrary to the "repeated orders of the Officer of the watch, put the helm to the "opposite side, *i.e.*, to port instead of starboard."

We have no cause whatever to question these statements, and we accept them as thoroughly authentic, but then we must ask this other question unconditionally, "How was it possible that six seamen, to "whose practical duty steering a ship belongs, and also the petty "officer entrusted with their charge, could all have lost their heads?" There is only one answer to this, "The men had not had ex-"perience as seamen of their work, otherwise the thing was simply "impossible."

Such things cannot possibly happen with trustworthy seamen of sufficient practical experience, such as one finds all other Navies, without exception, choose and constantly practise for such important posts as the steering of men-of-war, where the greatest attention is required and responsibility rests.

As little would a whole corporal's (squad) charge, who had served for several years, with an experienced non-commissioned officer at their head, turn stubbornly "right about," when repeatedly ordered "left about," even if one were possibly to do so; just as little would seven really practical seamen with a petty officer, "port the helm" when commanded, and at the same time signalled with the hand to "starboard" it.

This can only happen with untrained sailors who have not had experience in large men-of-war.

The "Havarei Commission," so says the North German *Allegemeine Zeitung* paper, has acquitted the helmsmen from the blame.

As it was established by the same official source, that contrary to orders the men put the helm to the wrong side, so we can only consider that the "Havarei Commission" has come to the same conclusion that we have. With this the report agrees, *i.e.*, that the six helmsmen were newly drawn recruits, whose capabilities nobody knew, and the petty officer on duty was a volunteer of one year's standing with insufficient seaman's experience.

But now, as all other nations only allow their men-of-war to be steered by picked men of standing in the Service, who have been proved capable in every way, *why does the German Navy alone form an exception?*

The answer to this question leads us to the deeper-lying causes of this fearful accident, which one has to seek for *in the system followed in our Navy.*

This system starts from the point, that the practical nautical experience, which other services have gained in the course of hundreds of years, and the wise and efficient laws that save their ships and squadrons from misfortunes, are considered to a great extent as superfluous in our Navy.

Those who issue the orders will not acknowledge that practical seamanship is the foundation of all naval tactics.

Instead of which, they replace it with theory and pure military principles, whose advisability we otherwise willingly admit to the first place both for Officers and men, instead of reversing it, because this is a false principle.

This unlucky system, that did not rule in Prince Adalbert of Prussia's time, luckily for the Service, is not only the indirect cause of the catastrophe, but must, if it is not given up, lead to the ruin of the Navy, of which the sinking of the "Grosser Kurfurst," and the severe damage to the "König Wilhelm," are only the commencements.

In every other naval service it has been acknowledged as necessary, that all new ships, but especially ironclads, should be tested in every way before placing them actually in service. Should they afterwards be joined to a squadron, the Captain is further given every opportunity of obtaining accurate knowledge of the peculiarities of the ships, and also of the capabilities of the Officers and crew, in order to rightly estimate the value of the latter.

Every series of these extensive trials requires four weeks at the least and often longer, and it is an unconditional requirement of seamanlike precaution, the neglecting of which immediately and painfully avenges itself, also the necessity of which is open to the veriest tyro.

But what is the case in our Service? The new ship "Grosser "Kurfurst" had solely tried her machinery before being placed in service, and after this no further searching trials were undertaken, as was the case with the other ships of the squadron.

When one knows further, as we have been informed on reliable authority, that according to Imperial orders, before our ships are joined to a squadron the preparatory drills are to be carried out in the fullest manner, as are the orders in all other Navies, and for which, as we have already remarked, four weeks at the least are required, therefore, one asks, "How was it possible that every seamanlike precaution "was neglected in such a way, and on the other hand, the Imperial "commands directly overlooked?"

If these Imperial orders had been followed, in all probability the misfortune would have been avoided.

In all probability, during the several weeks of preparatory drill, one

would have remarked the incapability of the helmsmen on board the "König Wilhelm," and of the petty officer of the watch, and have replaced them with more fitting men, or those would have become better acquainted with the peculiarities of the ship and rudder, and by more lengthened practice more competent to perform their duties.

It might be noticed at this point, that the remark made by several of the newspapers, that the misfortune was partly to be attributed to the bad steering capabilities of the "König Wilhelm," is a mistake, since we know from good authority, that the "König Wilhelm" steers and answers her helm, thanks to the peculiar construction, much quicker than any other of our ironclads. Only it is absolutely necessary that the helmsmen understand their work, which is impossible in this ship without previous and lengthened practice.

From the above, which is supported by the facts, one may see that the foundering of the "Grosser Kurfurst" was not solely the result of an unfortunate chance.

One might still allow a certain, though always poor excuse, had there been any danger in delay, but as far as we know there was none in any way.

Why was it necessary immediately to form the ships into a squadron, after a scarcely finished and unduly hurried fitting out, and to send them to sea two days afterwards unready for their work?

The war was ended, during whose most stormy period our wooden ships in the Mediterranean amply sufficed, and in no place lay political grounds so constrained as to require the despatch of the ironclad squadron at the cost of their safety, the circumstances themselves show; for after the accident, not only was no other ship sent out, but on the contrary the "Hertha" was recalled.

What then was the cause of this most wonderful proceeding? If we call the cause by its right name, it was despising all seaman-like practices and experience. All other nations were to be shown, "See "what efficient people we Germans are in comparison to you! You "require two months to send an ironclad squadron to sea, we only "two days!"

The false system has fearfully avenged itself!

We now come to the second point.

The question has frequently been raised by the public if the formation in which the squadron was moving was not too close?

We do not hesitate in answering this question with an emphatic "yes."

The "Naval Officer's" official article in the *Weser* paper of July 7th, tells us that the evolutionary rules ordered by the Emperor require a distance of 400 metres (440 yards) between each separate ship of a squadron. This is a very wise regulation; for at this distance the ships can without danger move out of the way when anything approaches them, and for these same reasons similar distances are the rule in all other Services.

What could induce the squadron commander to shorten this usual distance to one-fourth, or 110 yards, in water so crowded with ships

as the English Channel, where moving out of the way may be necessitated every moment?

As far as is known there was in no way any cause for it, and so long as the chief naval authorities cannot show us with convincing reasons any other ground, we have the right to consider the closed formation, in which the ships were obliged to run into one another as soon as anything happened, only as an endeavour, as already remarked, to excite the respect of the English.

As to what extent it succeeded, the *Times* gives us an insight. In its account of the disaster in the beginning of June, it says:—"The "cause of the catastrophe is in the first place want of experience. "Had the Germans had such experience with ironclads as we have "had, they would not have chosen such a short distance between their "ships."

This is rather discomforting for the German Navy, but the *Times* could not well decide otherwise, since the internal affairs were not sufficiently known to it.

If, however, the motives for this close formation had met the eyes of the English, through the "Naval Officer's" above mentioned article to the *Weser* paper, our naval service would have had to hear other and very much more disagreeable things.

This article says that close order of sailing was recognised as the best by the Officers at the Admiralty at Berlin, in the naval *Kriegsspiel*, and therefore chosen.

We must admit we scarcely trusted our eyes as we read the above, and nothing can better justify our publicly made statement, that practical seamanship was considered as superfluous by those at head quarters, than these words.

So now naval manœuvres are worked out in a room with pencil and compasses on paper. That is a grand invention! Since the "Naval "Officer" does not say that some practical trial is also necessary, but solely explains and produces complete the manœuvres composed at the green table as the best. So in future our naval Officers only require practice in geometrical constructions, and they are qualified to lead the fleet against the enemy and of course to beat him.

Different small points upon which the seamen of the old battles were accustomed to lay some weight, as for instance, currents, irregular steering, sudden avoiding of collision, the smoke of powder and coal, accidents to machinery and rudder, &c., certainly have not been taken into consideration by the tacticians at the Admiralty; but what does it signify? That is a long passed standpoint, according to the views of the newest school to which the "Naval Officer" appears to belong.

The "Naval Officer" makes some more similar statements.

He explains that the close formation, off Folkestone, is not to be surpassed for warfare, and is also perfectly free from danger, if the rudder and machines do their work.

Certainly, but would not there be much deeper contentment if we were at war and the ships with their perfectly unpractised crews gave some surety that the rudder and machines would do their work?

What would a General in command say if the commanding Officer of a cavalry regiment, whose troopers were composed of almost two-thirds freshly drawn recruits, if after being on their untried horses two days, he lead the regiment on the third day in close formation to the attack?

Now, apart from the lameness of every comparison, that was the situation of the fleet on the 31st of May, with undoubtedly the marked difference that the military manœuvre on land would not cost the country hundreds of men's lives and from ten to twelve million marks.

Lastly, does the "Naval Officer" believe he will be able to put the public off by saying that at some time it might happen in the Army as it has done in the Navy, that a "right about" instead of a "left about" might once be made.

Therein we allow him to be perfectly right, only in the Army the single men, the files and the lines of movement are usually at such a distance from one another, that in case of a false turn they do not mutually touch one another, to say nothing of running their heads together, and that is what is required for the fleet formation in the Navy.

Besides this there is another astonishing circumstance in the "Naval Officer's" explanation.

According to our knowledge of military affairs every tactical and drill movement requires the Imperial sanction, and without this no kind of alteration may be introduced by any commander of troops or single Officer.

How is it now the Admiralty Officers suddenly, on the ground of their experience won at the naval *Kriegsspiel* at Berlin, resolve on such a radical change of the rules, which brings such fatal results in its train?

Do they support themselves at least on the sanction for the alterations by the Board of Admiralty, which according to Imperial decree shall meet for all important questions touching the Navy? The "Naval Officer" does not mention anything about it; further, have we not heard that the Board of Admiralty composed of the oldest naval Officers, has never been called together since their installation seven years ago, and we beg to be informed if we err in this point. So then we see from the preceding that the "Naval Officer" has been unfortunate in his expectations and one can really say here "*Si* "*tacuisses.*"

This striking article gives quite the impression of having been written by command, and we believe we do not err when we describe the position of the author in the Navy as solitary.

Lastly, one other point requires publication.

In the first accounts which the English papers gave of the collision, it was noticed that an account of the late arrival of the boats of the ironclad "Preussen," hardly any of the drowning were saved by her, and to this was added that this circumstance required to be cleared up. Carefully as we have read all the papers, up to the present no such explanation has appeared. According to the information col-